

Optimization for Energy System Integration

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Prepared For:

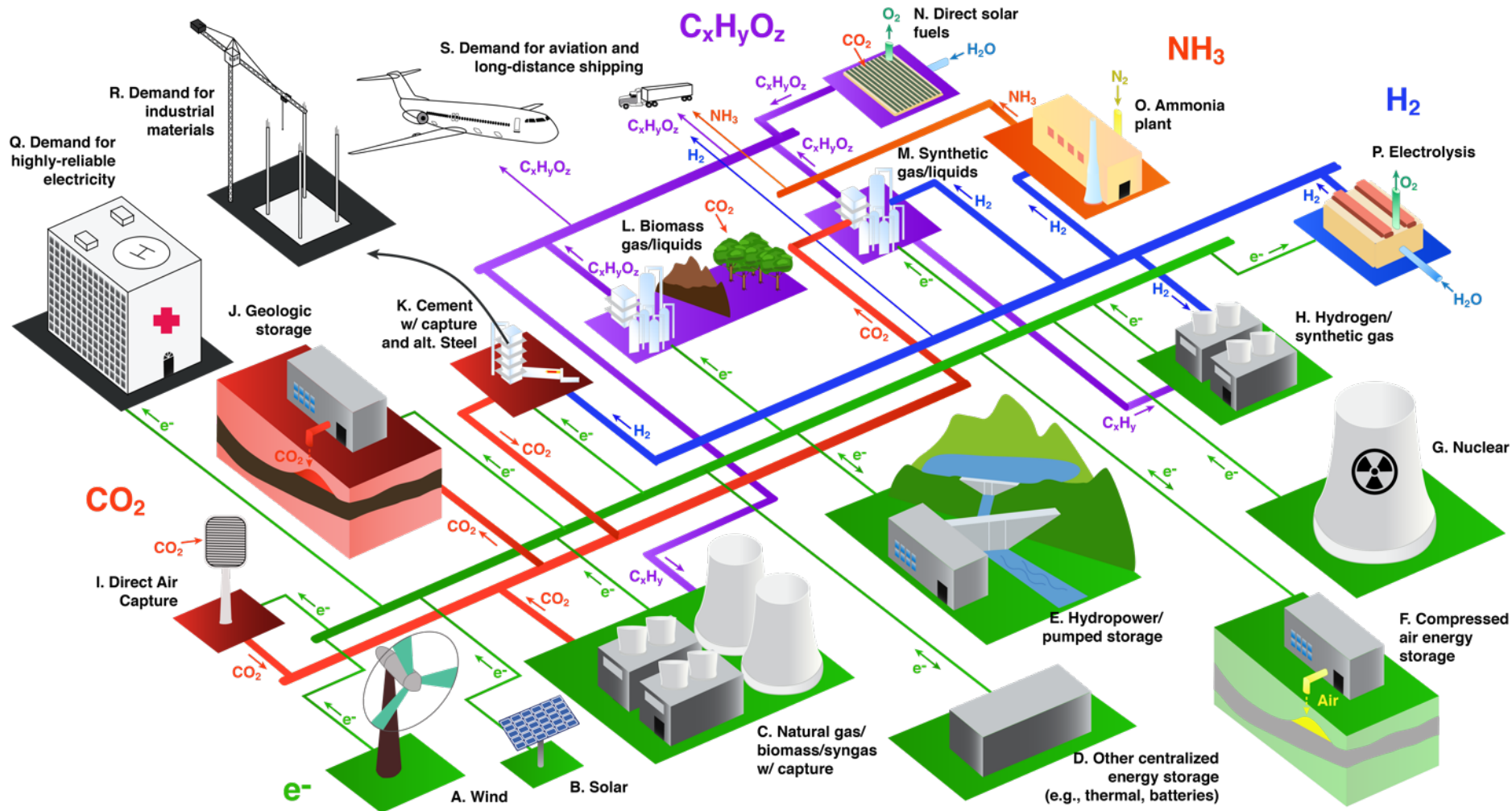
**ESIG Spring Technical Workshop 2020
(Online)**

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The Whole Economy Needs Energy



Davis et al. *Science*, 2018

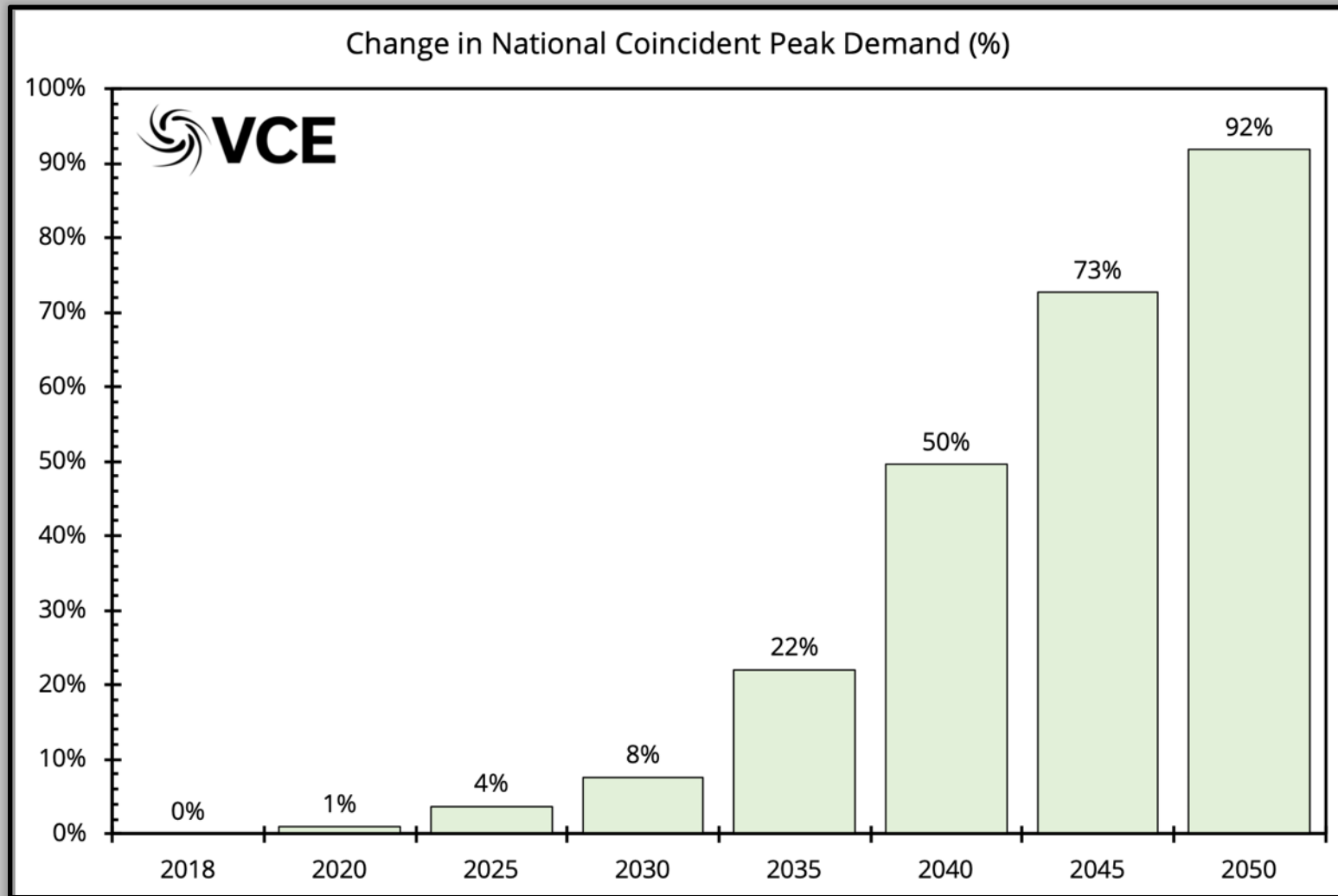
Electrification that WIS:dom® Considers

The WIS:dom® optimization model considers **electrification through:**

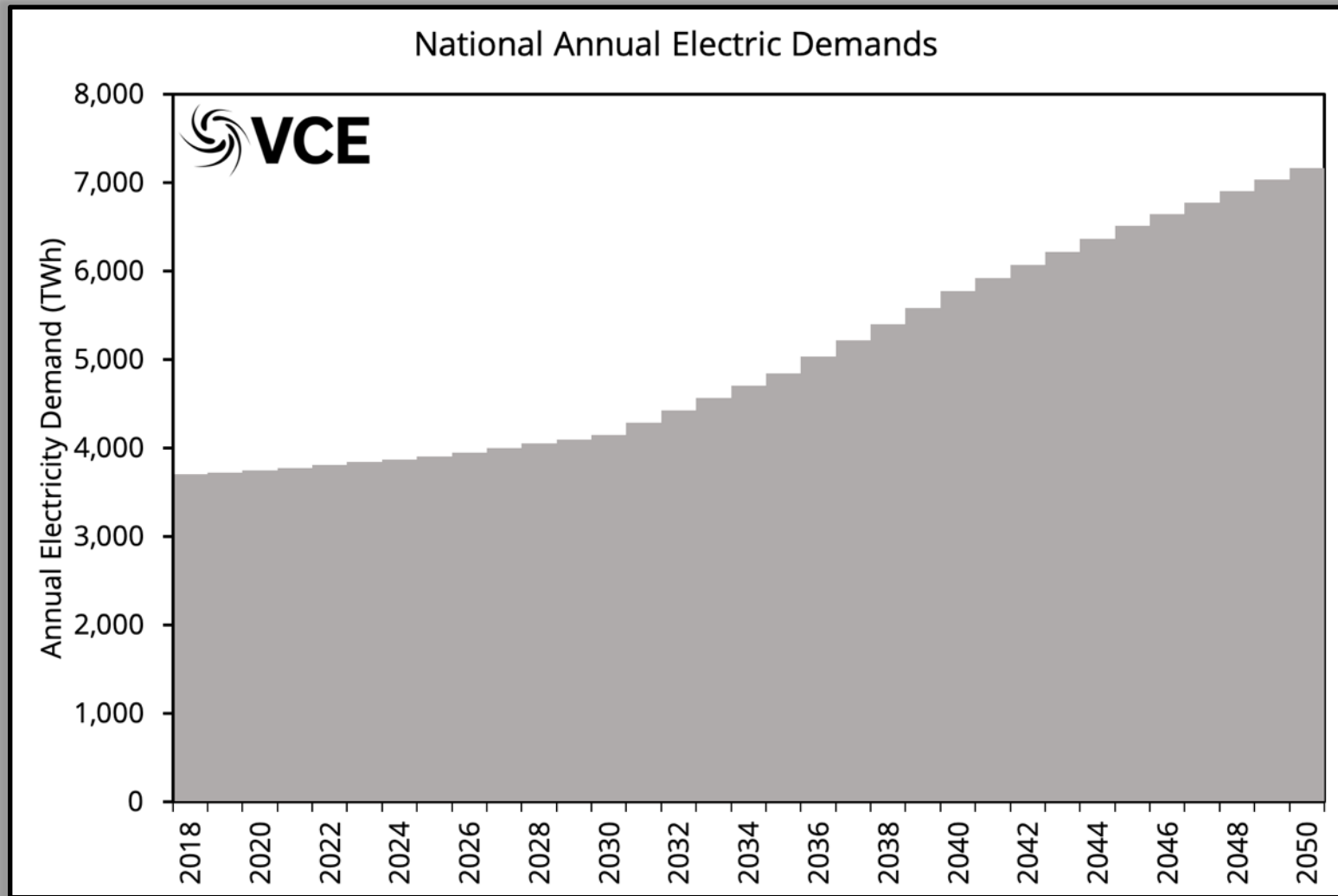
1. Light Duty Vehicles,
2. Heat pump Water Heaters (residential & commercial),
3. Heat pump Space Heating (residential & commercial),
4. Transportation,
5. H₂ production for:
 - *Medium / Heavy Duty Trucking,*
 - *Industrial Demands,*
 - *Space heating (residential and commercial),*
 - *Other processes (Sabitier to Fischer-Tropsch Processes).*

Note: WIS:dom® does this while also considering weather and climate change impacts on each area of the energy system.

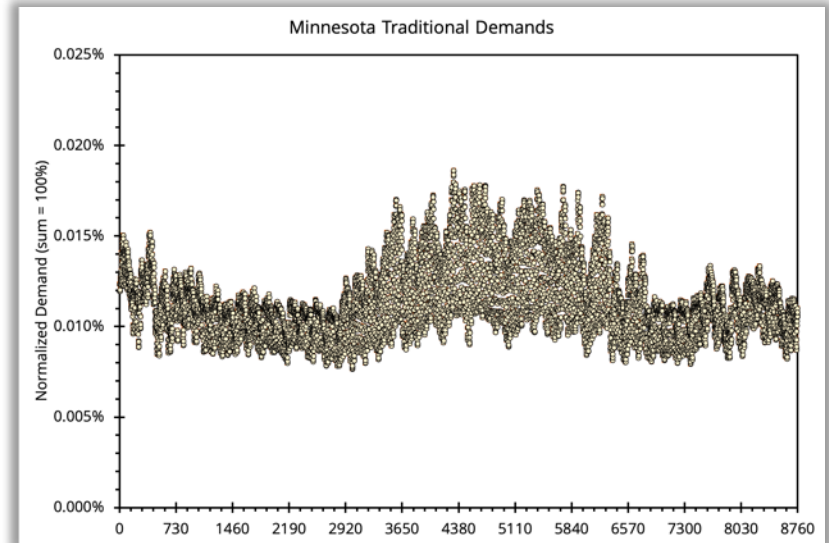
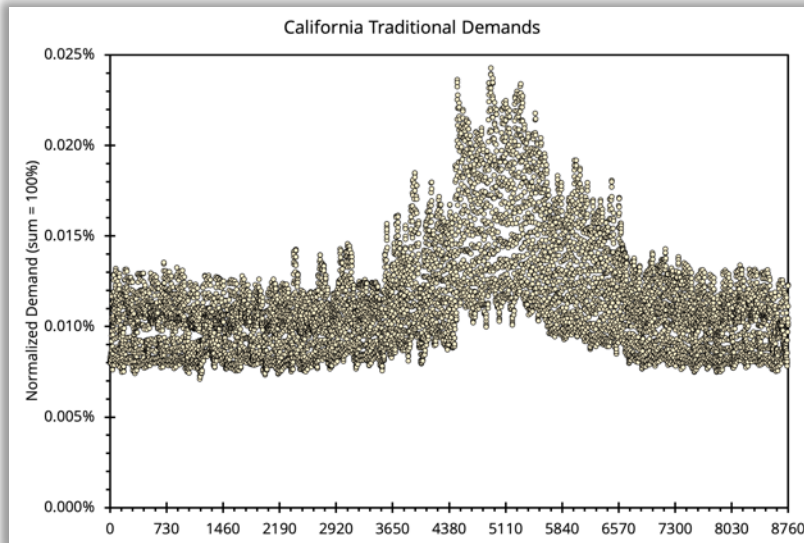
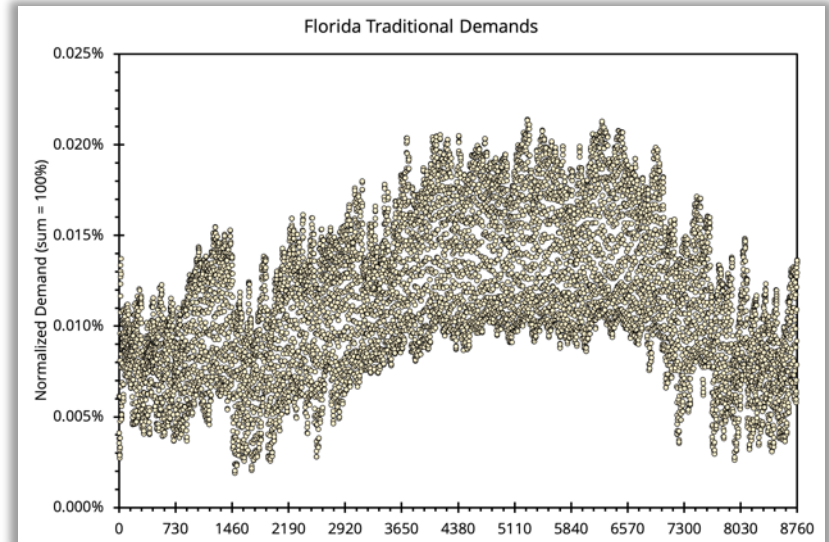
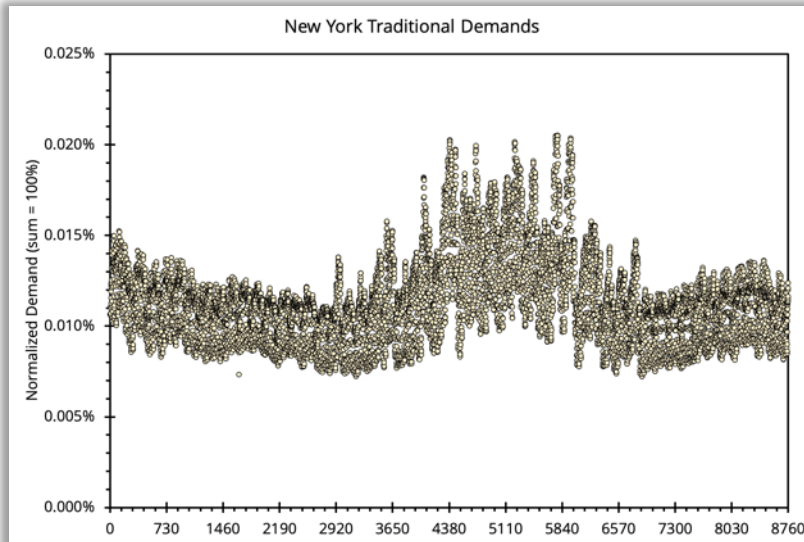
Electrification Changes US Electricity Needs



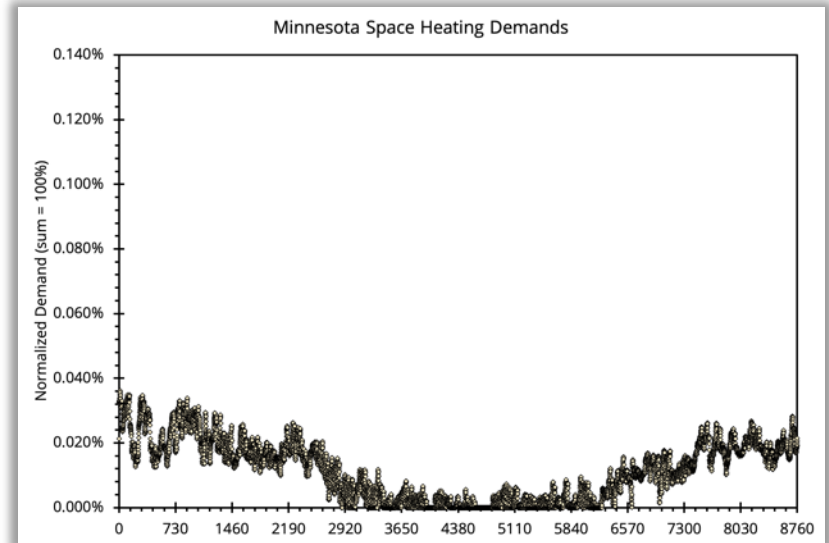
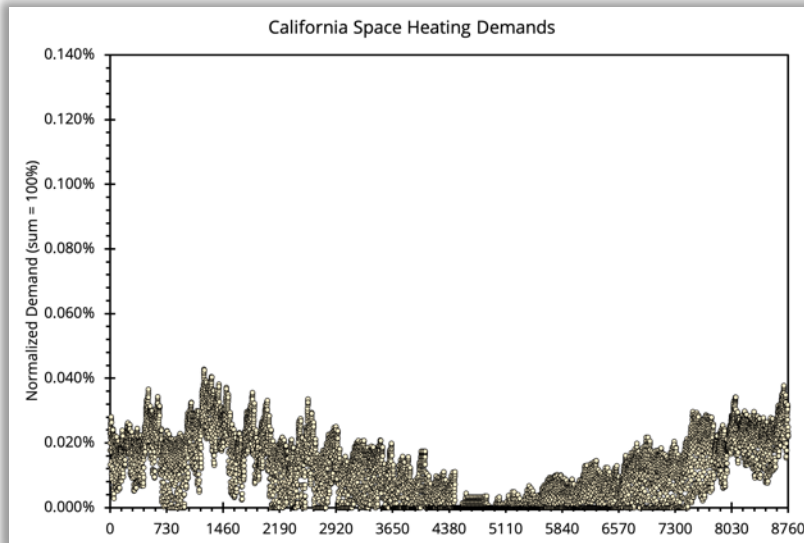
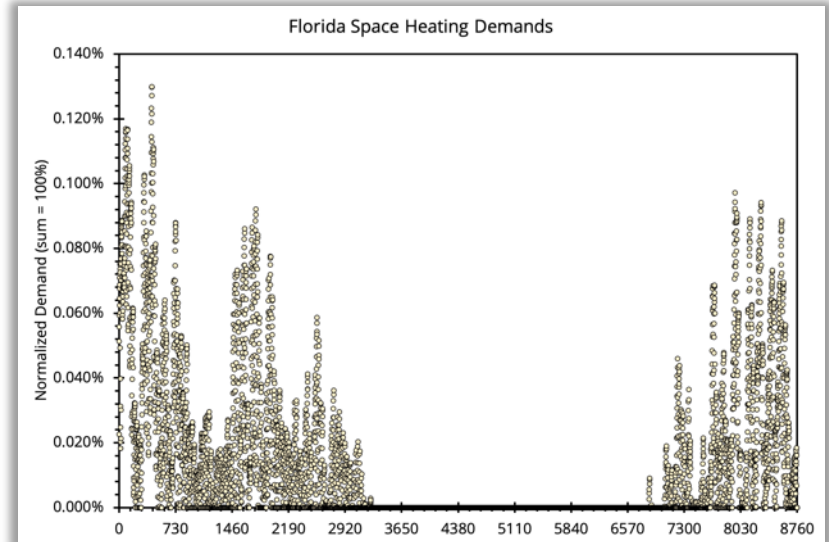
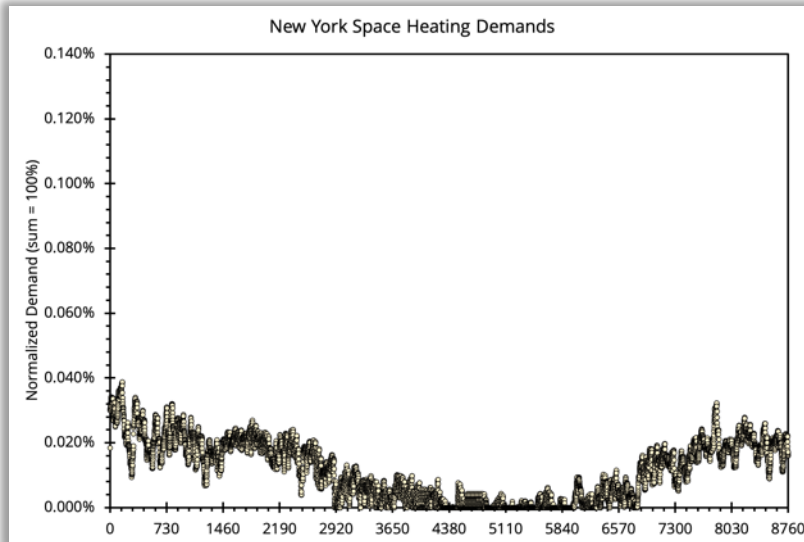
Electrification Changes US Electricity Needs



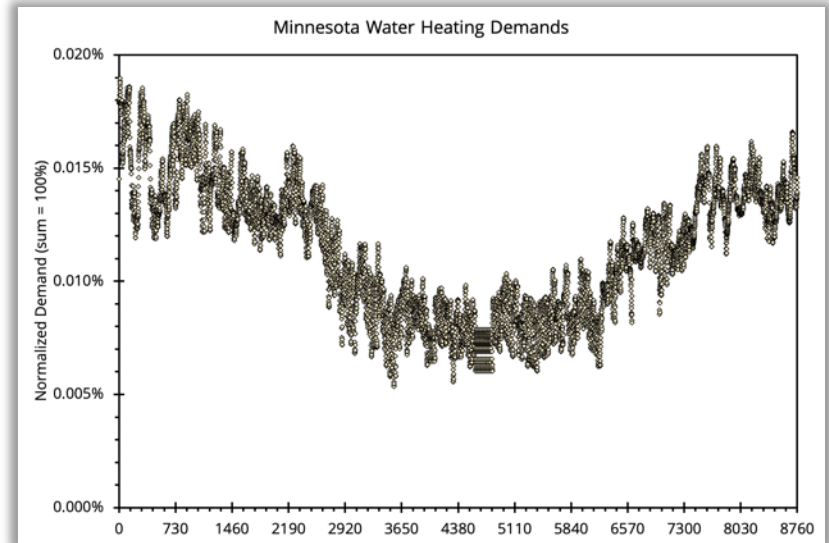
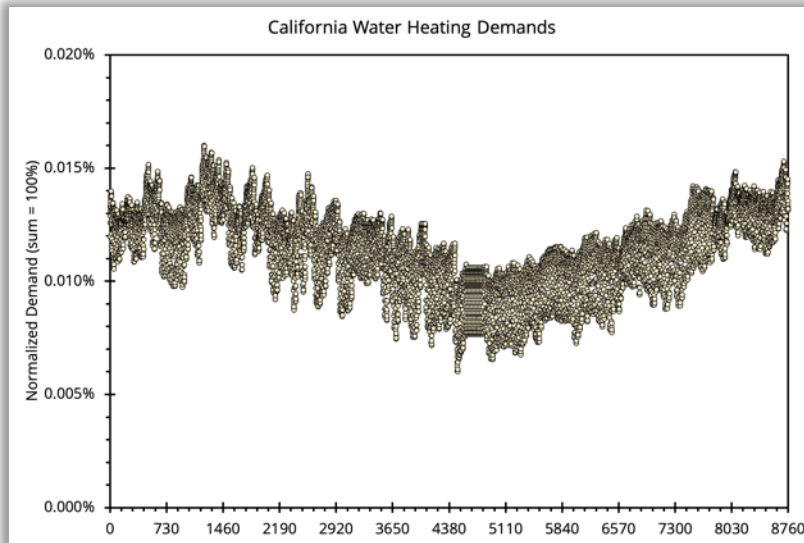
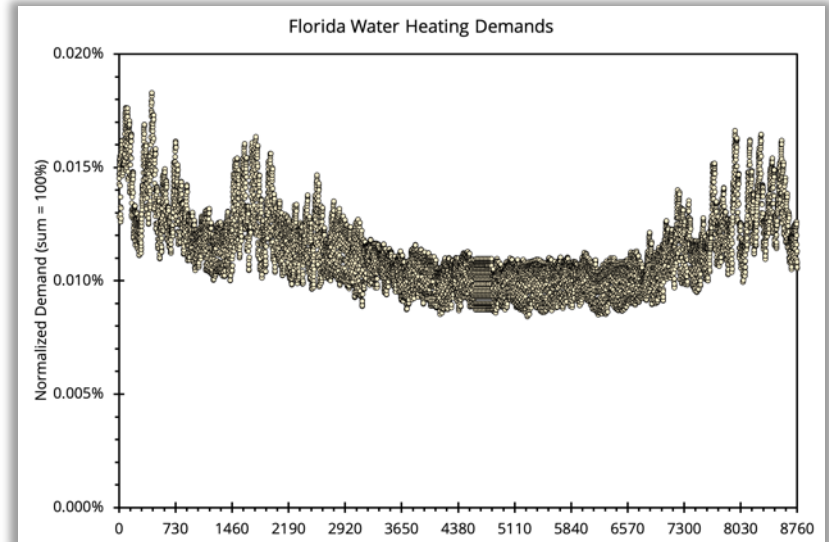
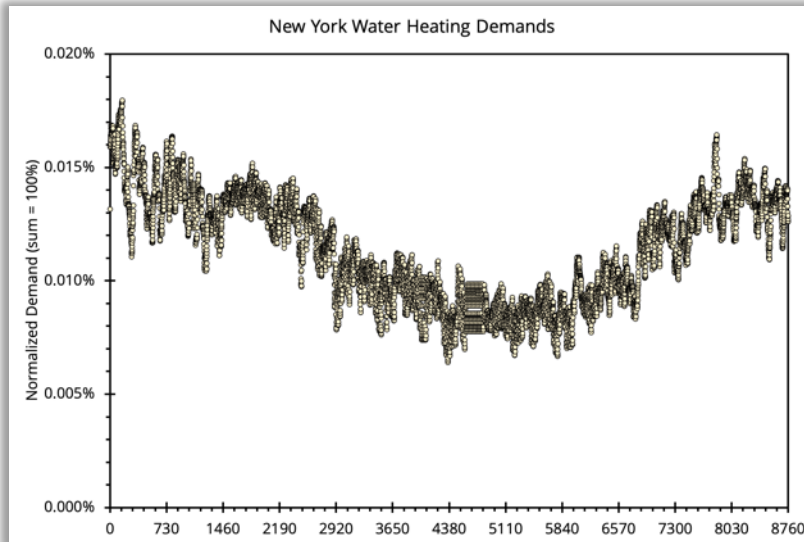
WIS:dom® Estimated Traditional Demands (Examples)



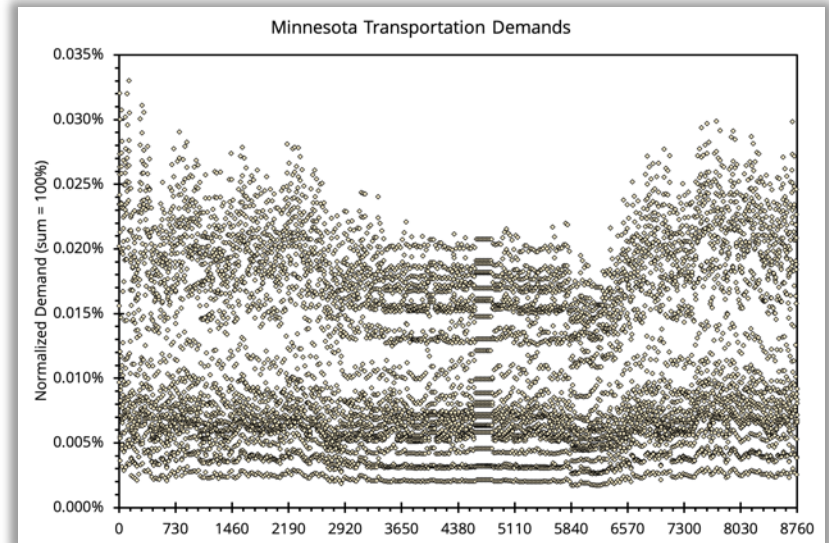
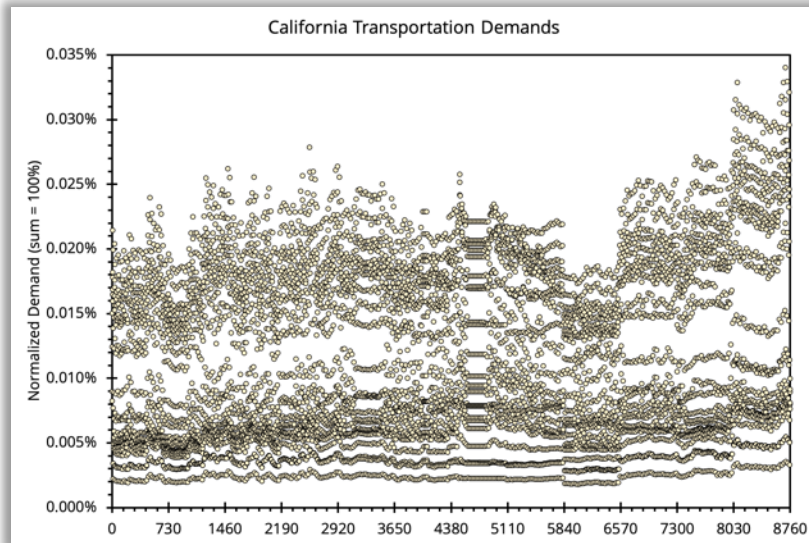
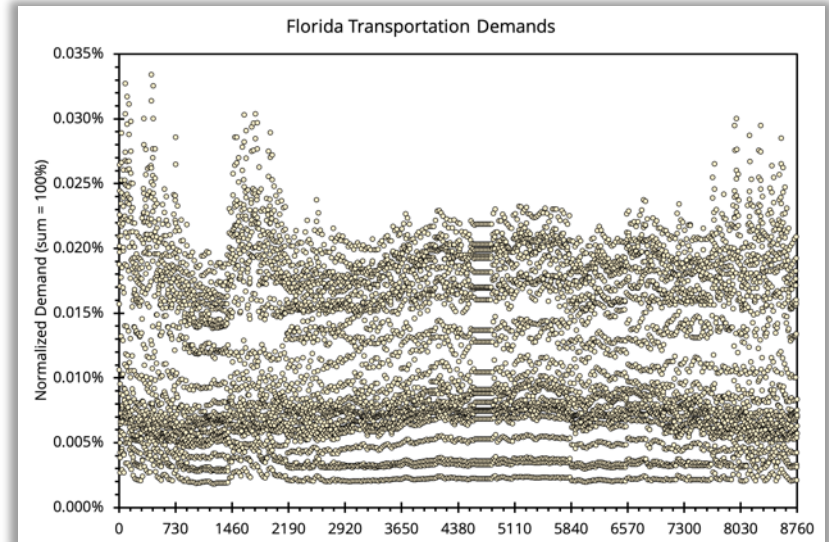
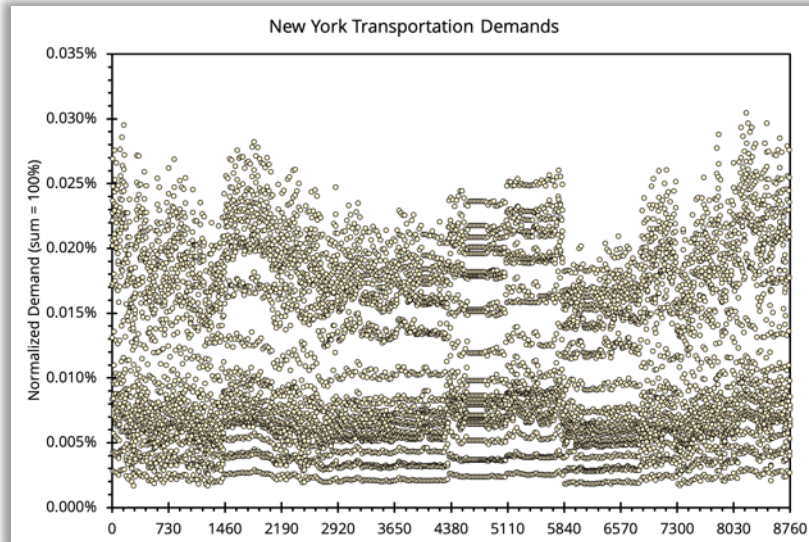
WIS:dom® Estimated Space Heating Demands (Examples)



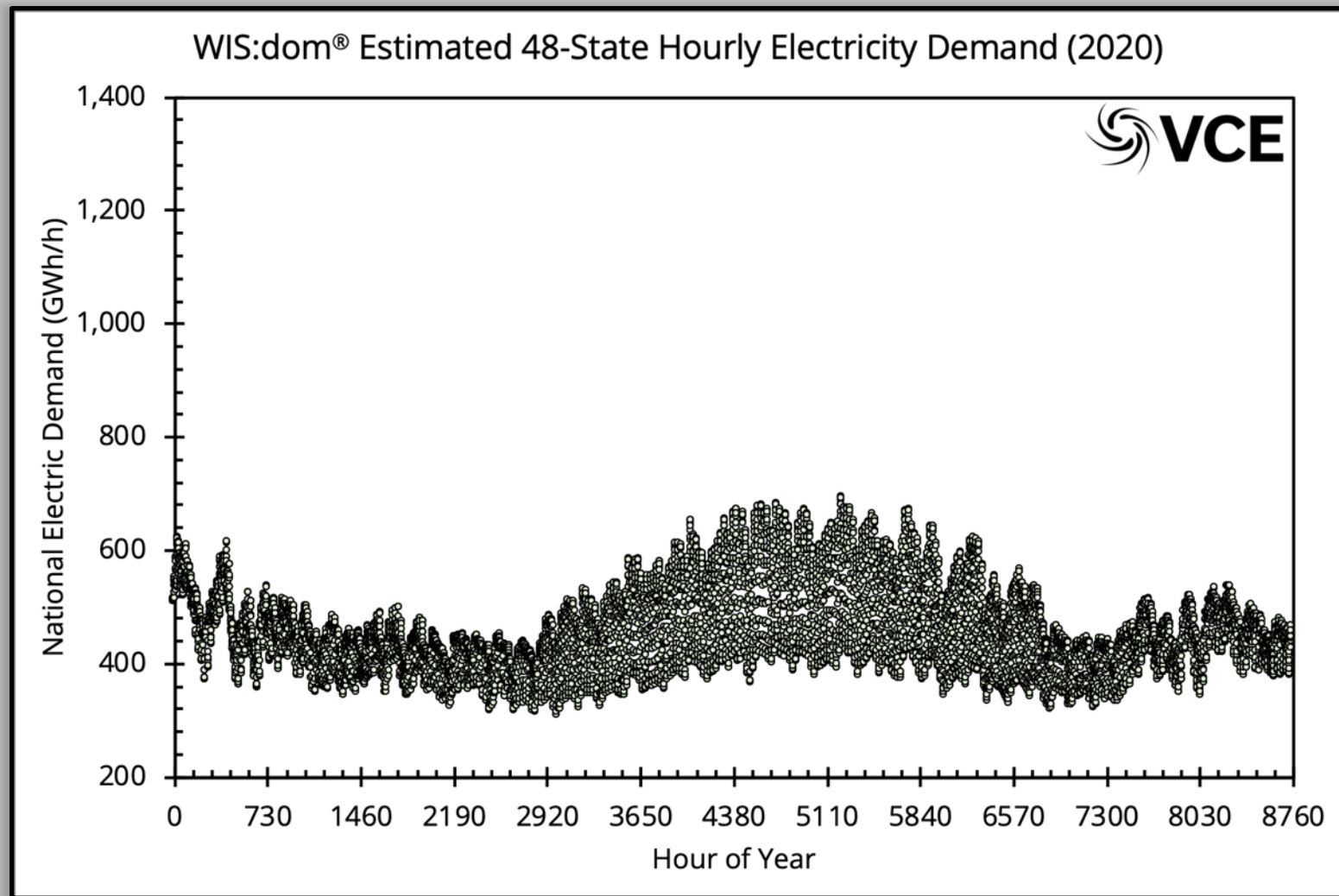
WIS:dom® Estimated Water Heating Demands (Examples)



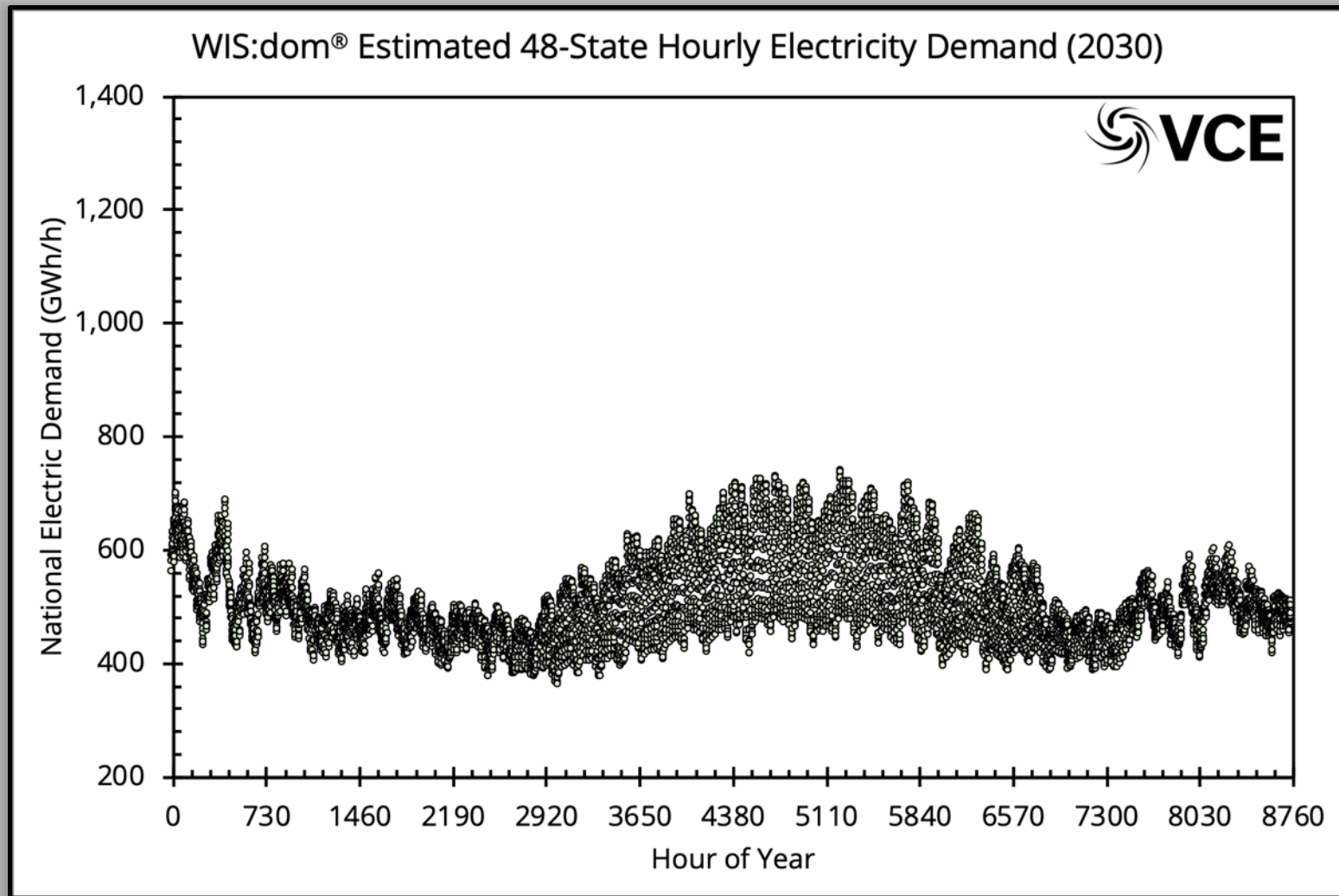
WIS:dom[®] Estimated Transportation Demands (Examples)



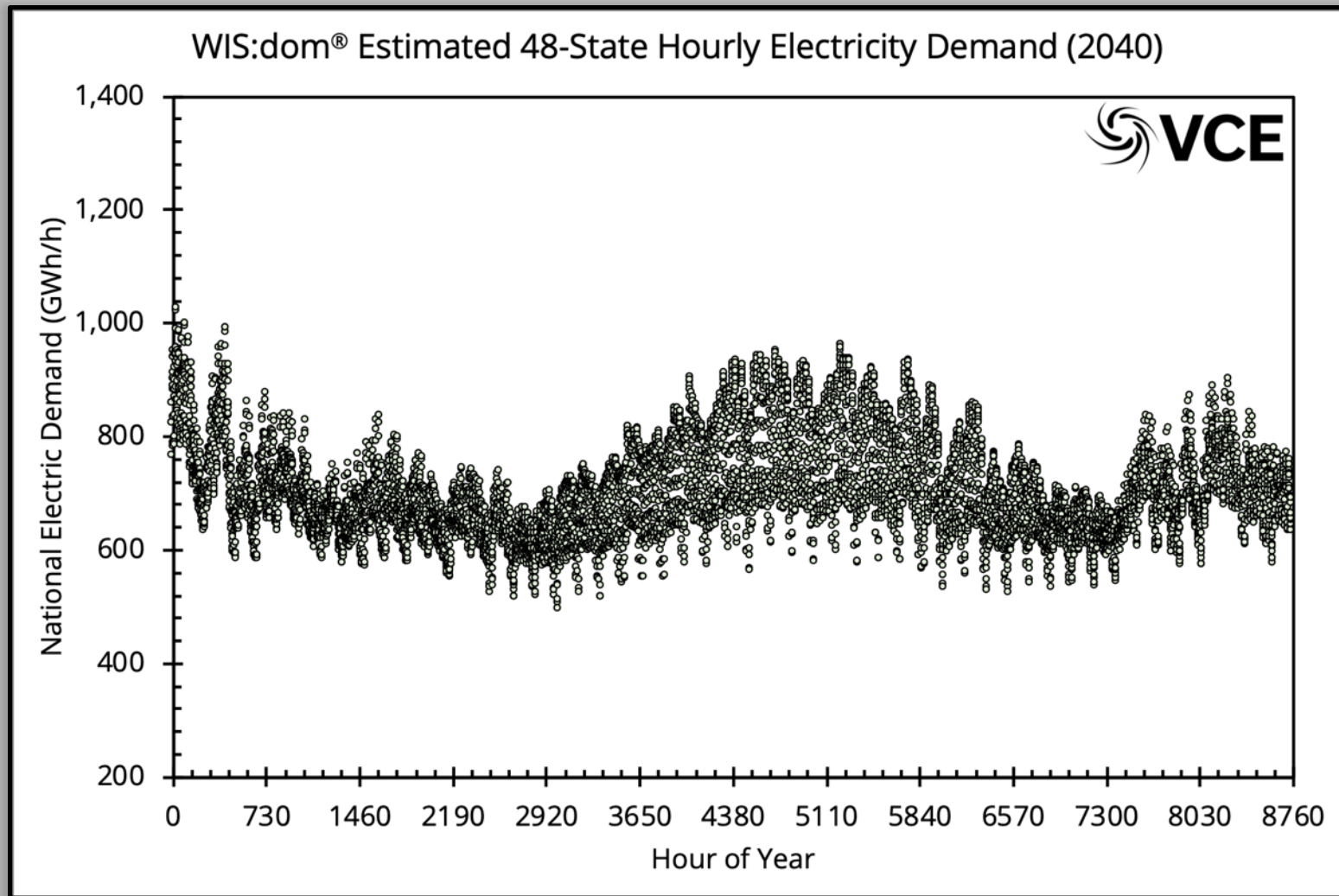
How Electrification Changes US Electricity Demand Profiles



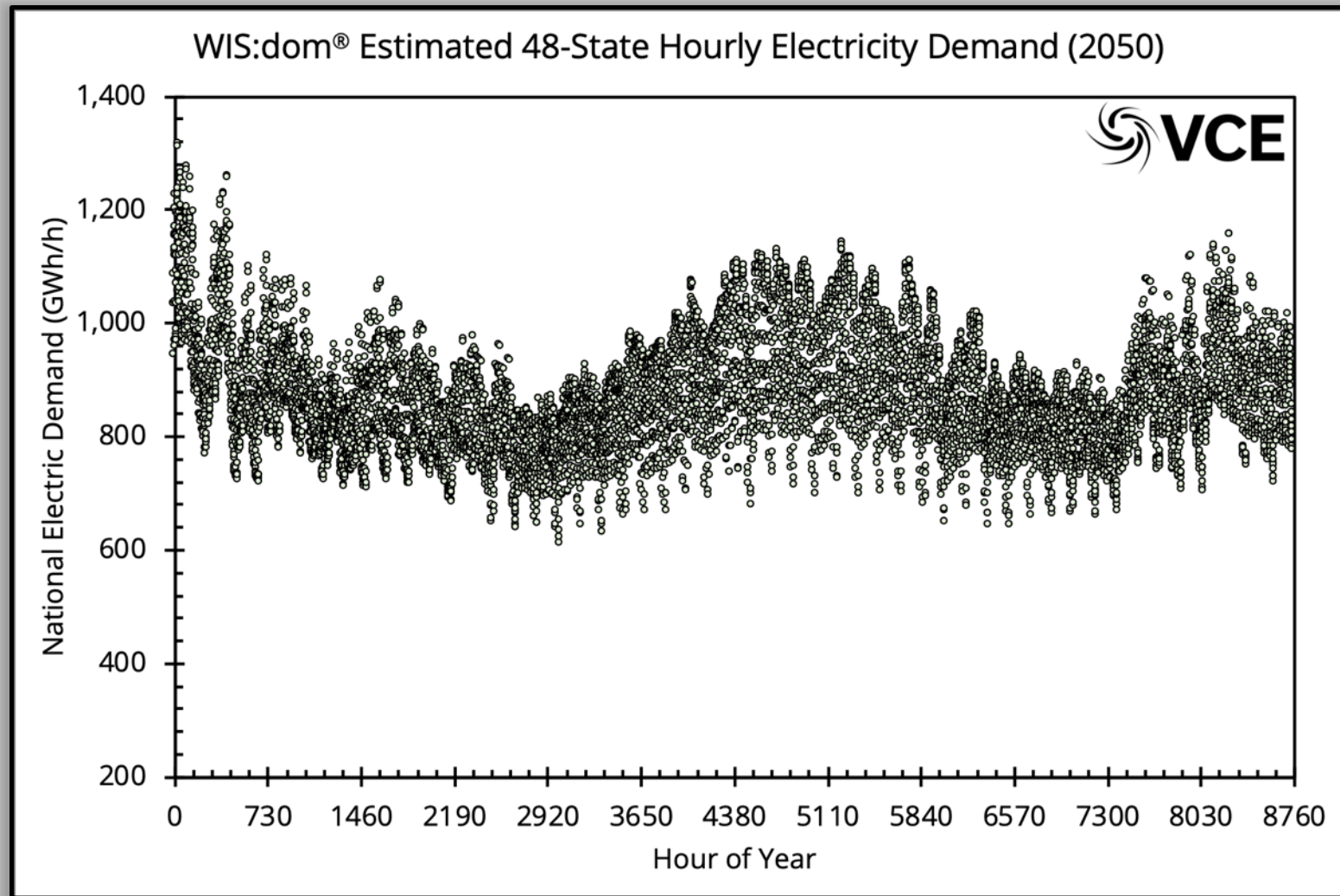
How Electrification Changes US Electricity Demand Profiles



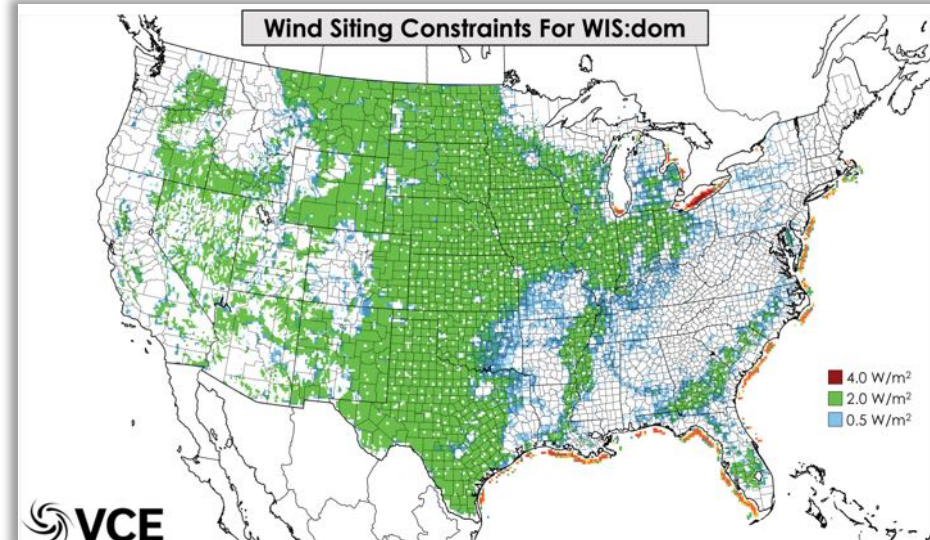
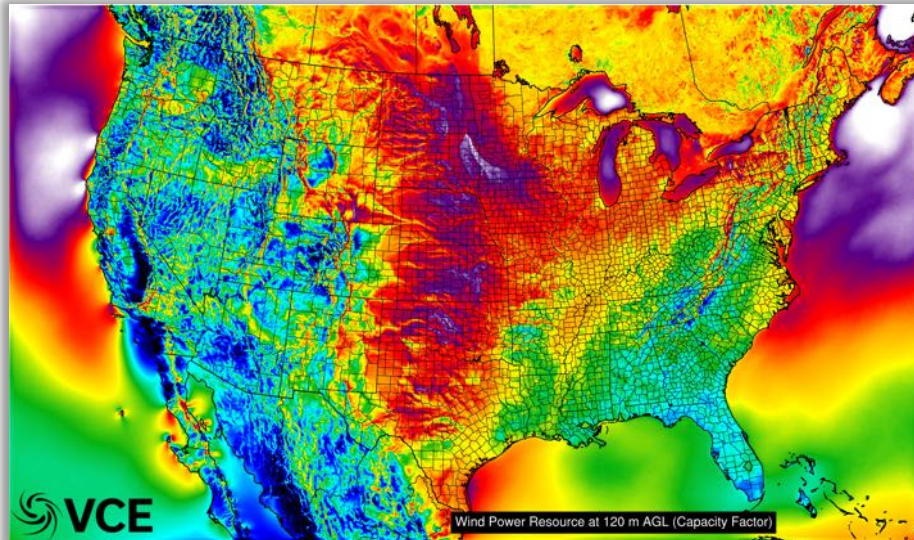
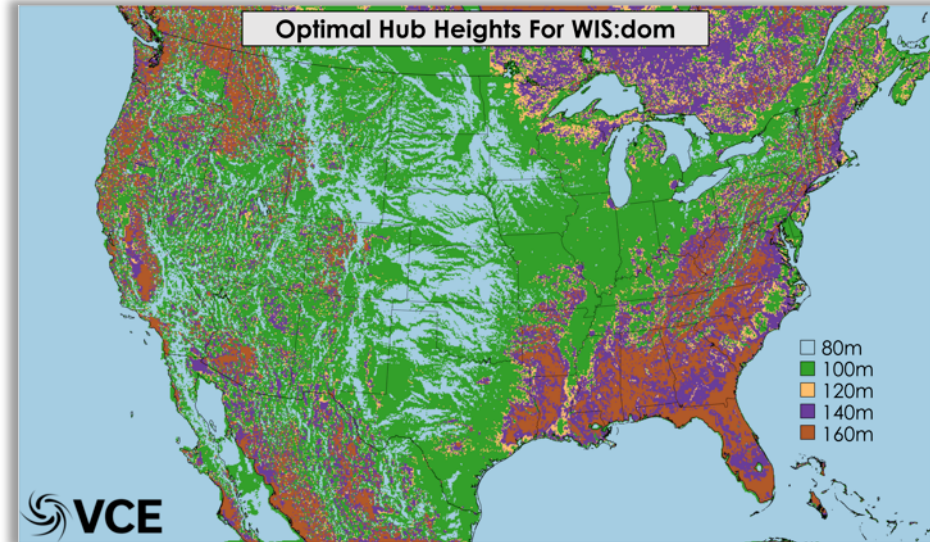
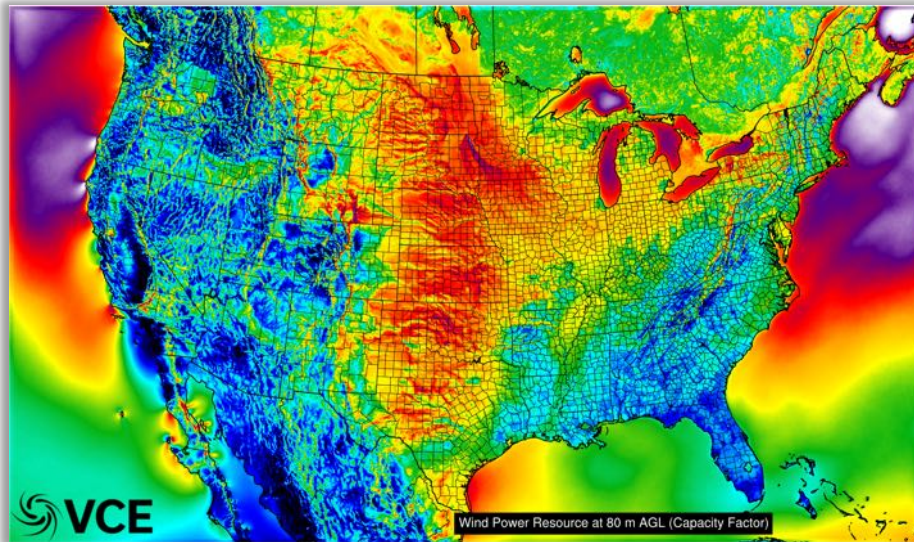
How Electrification Changes US Electricity Demand Profiles



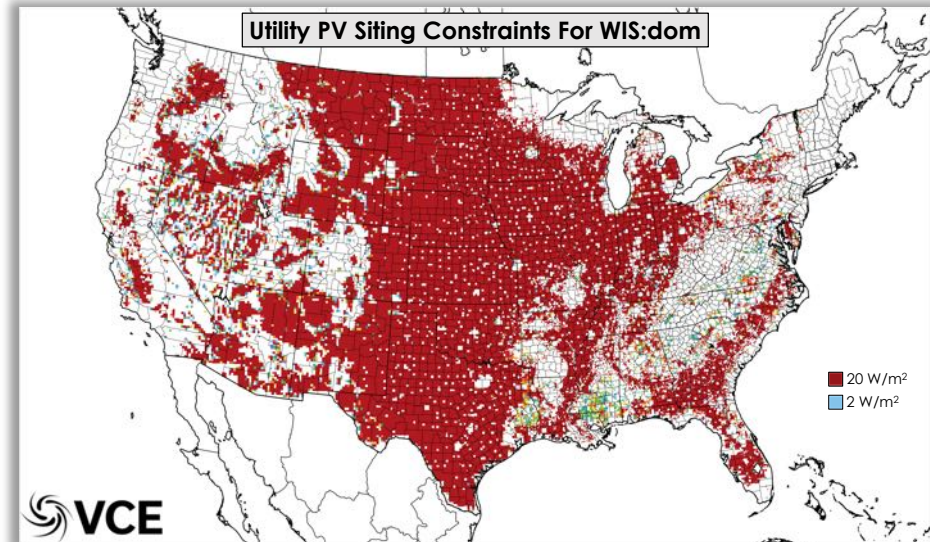
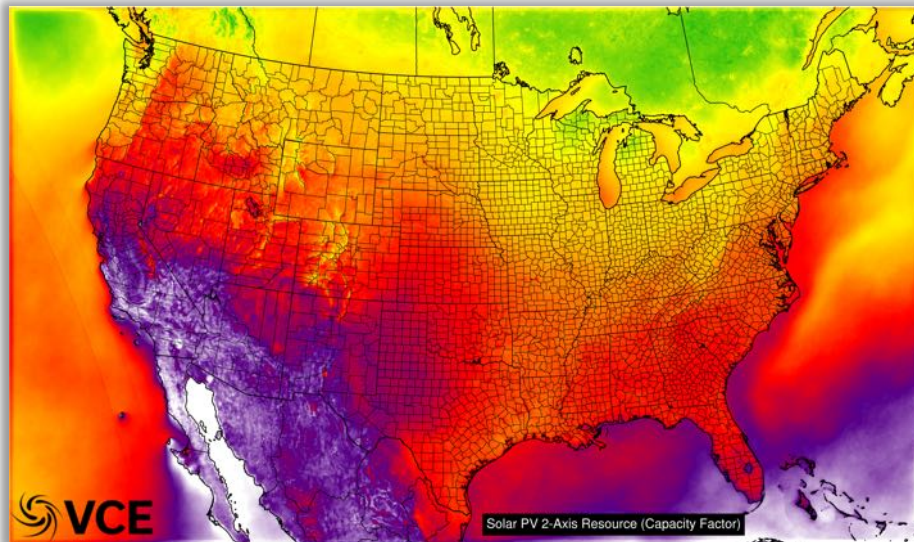
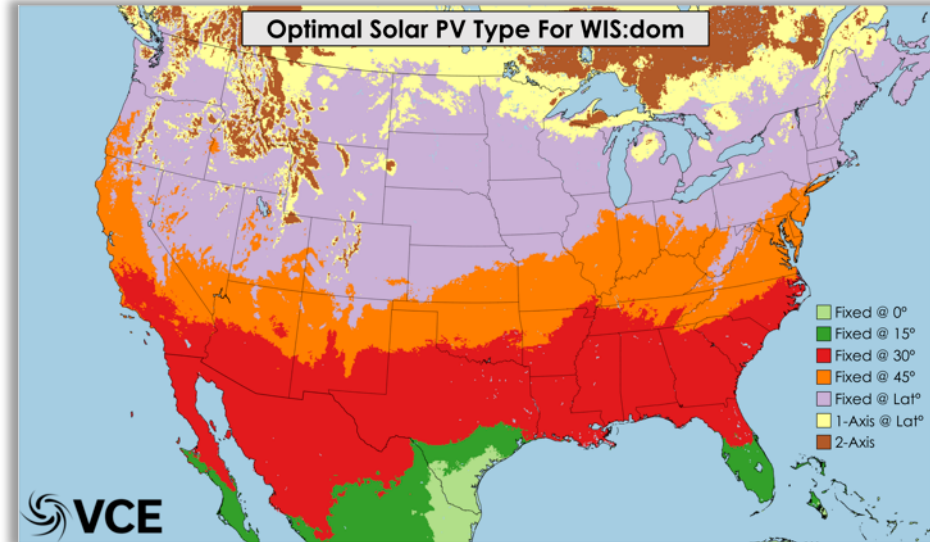
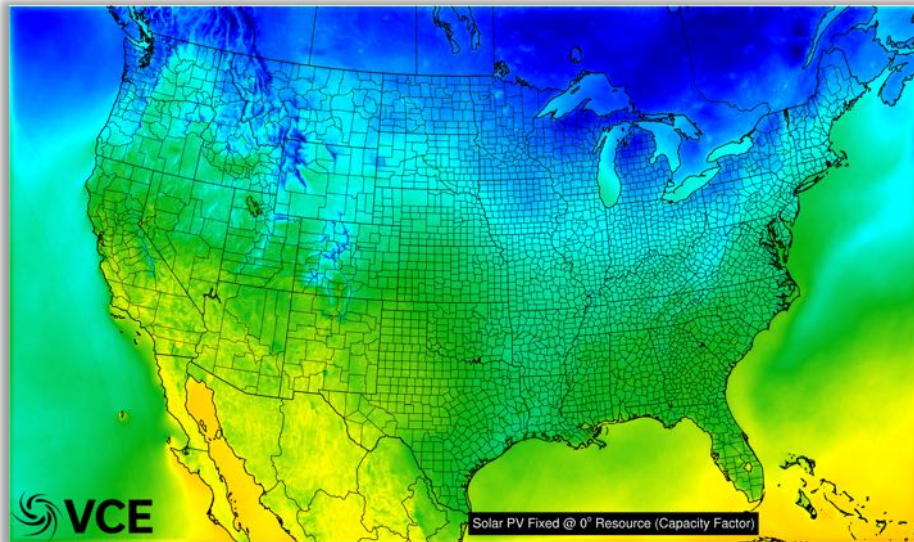
How Electrification Changes US Electricity Demand Profiles



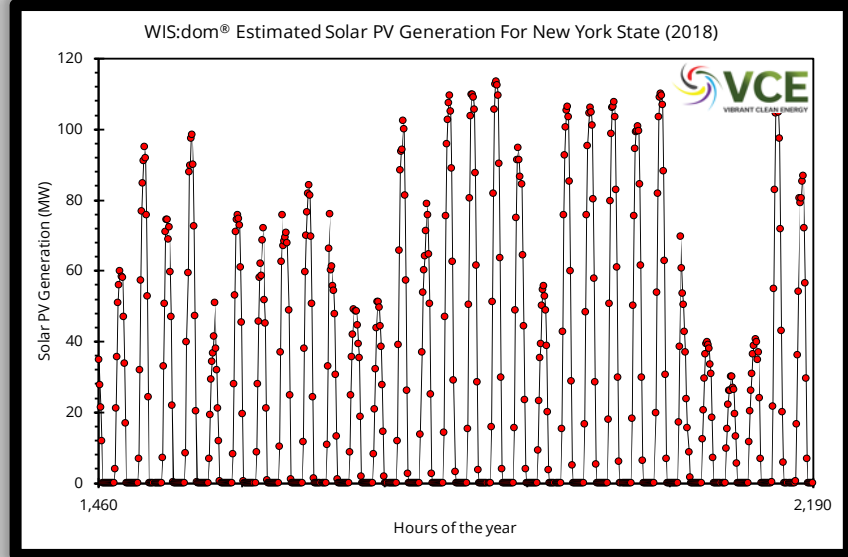
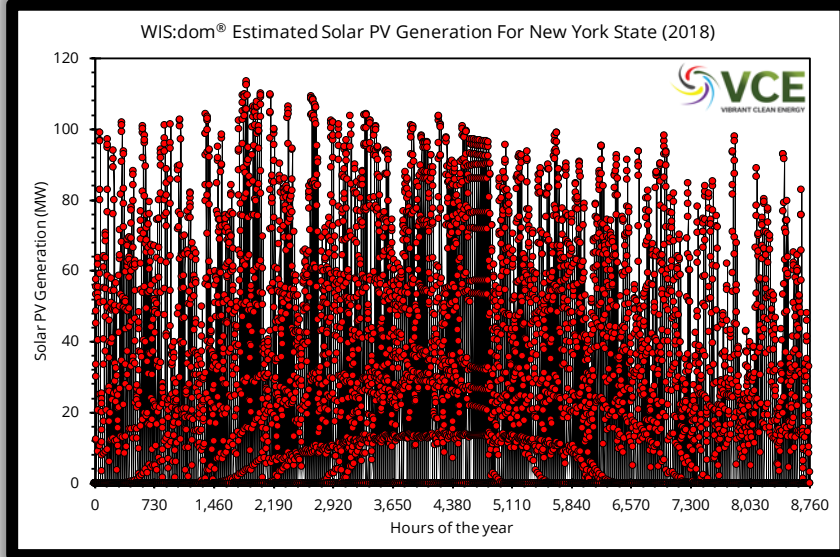
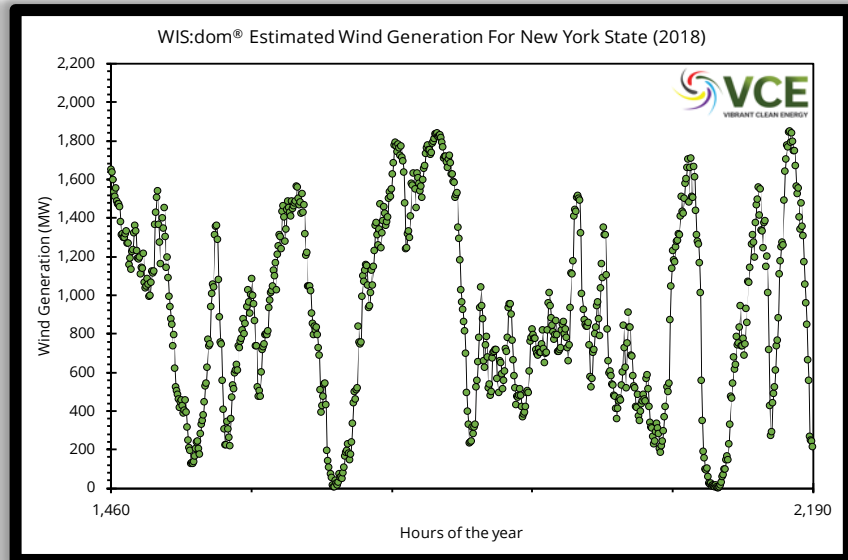
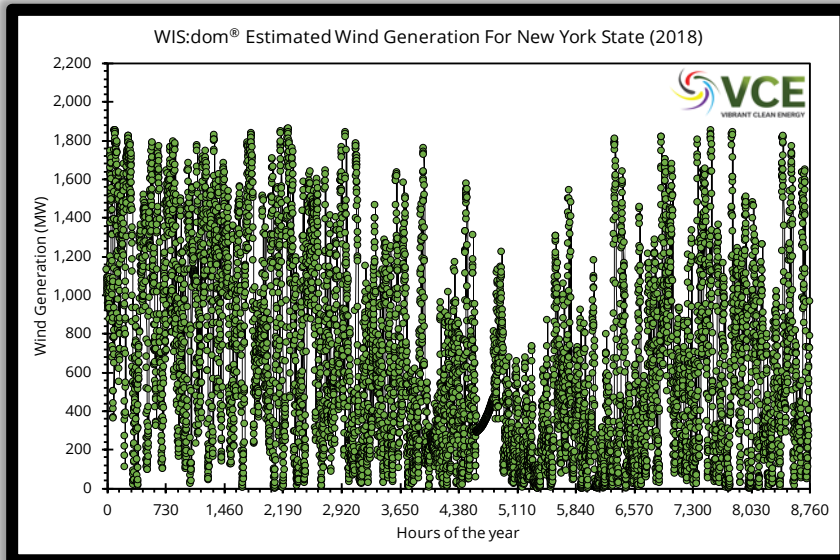
Detailed wind datasets are critical for resource siting



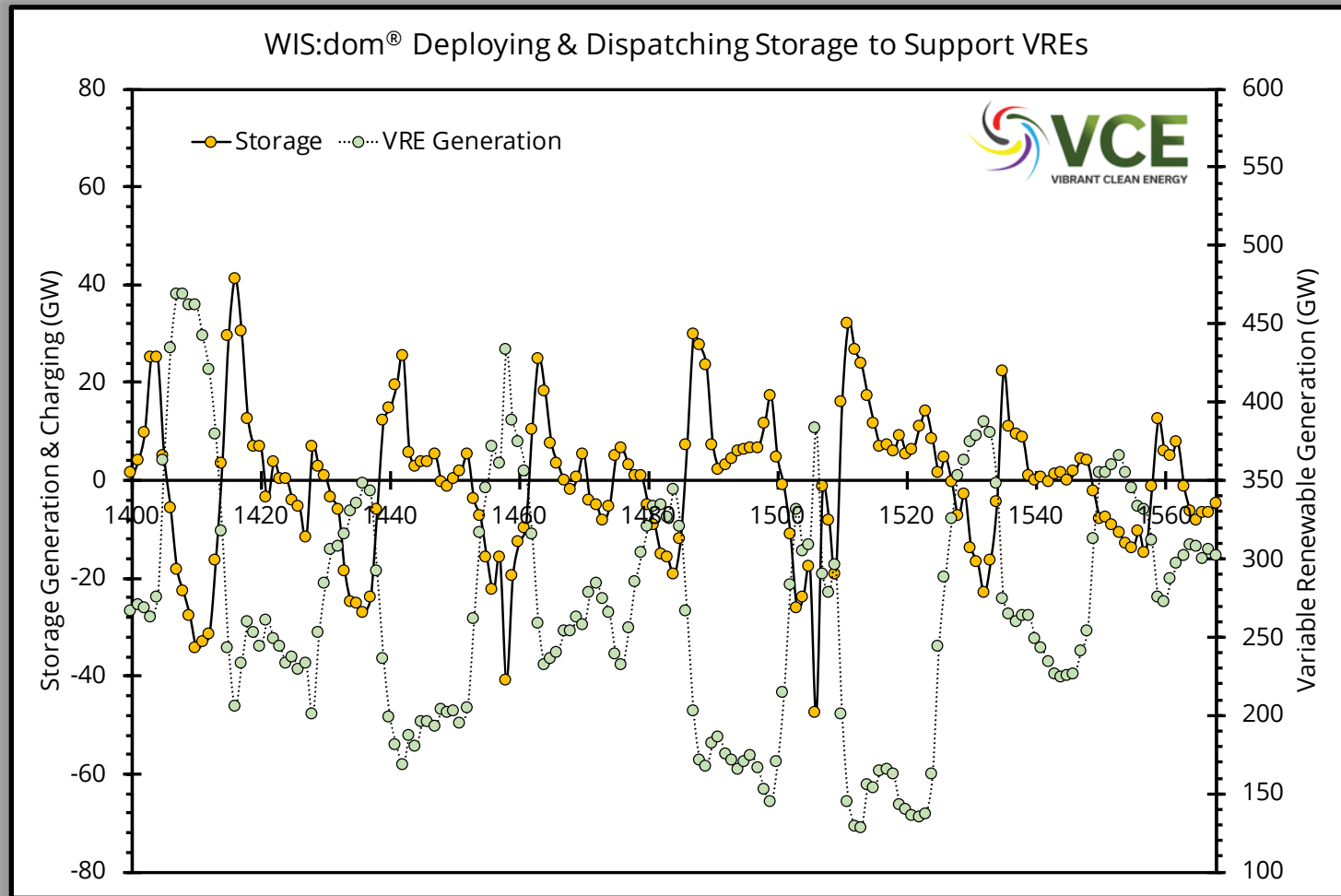
Detailed solar datasets are critical for resource siting



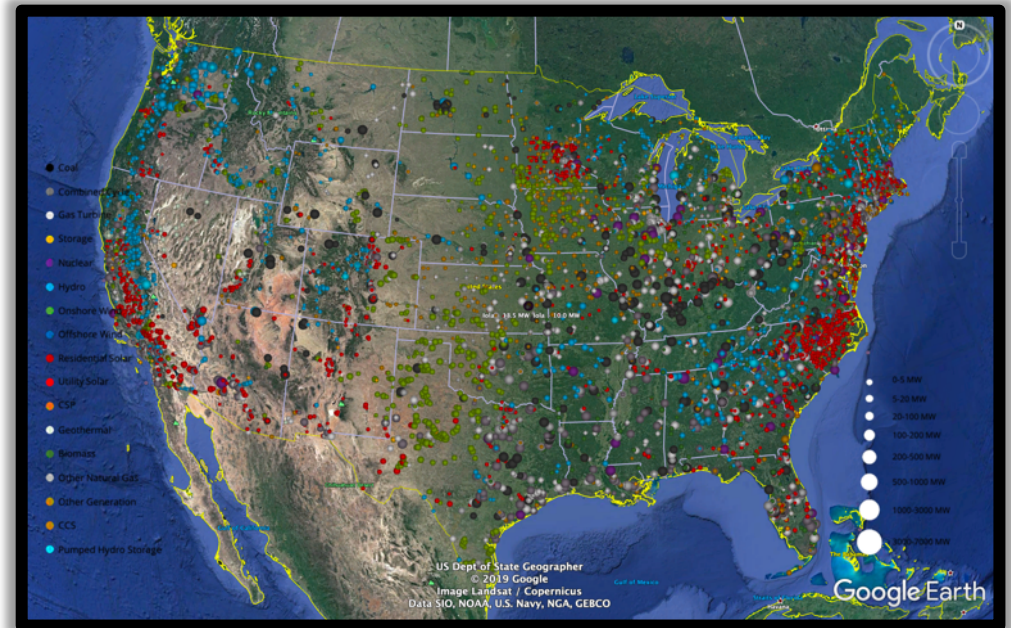
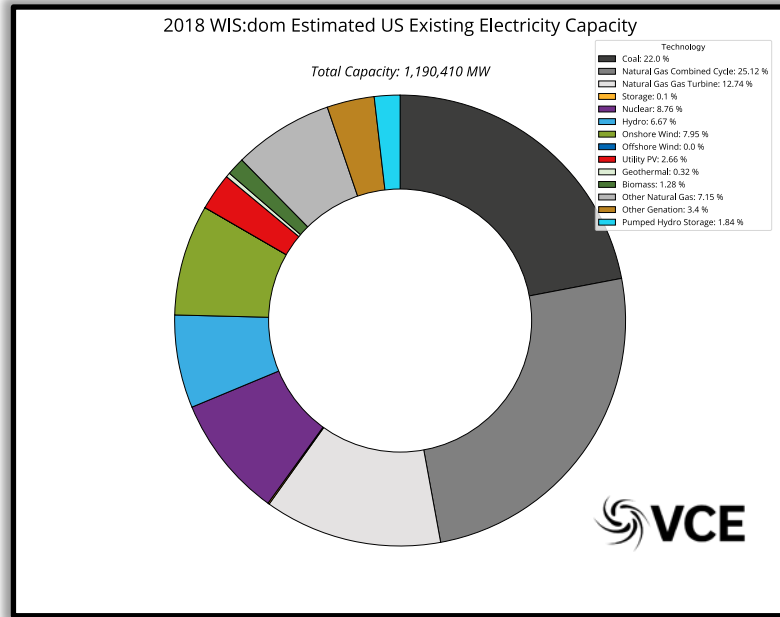
Use of hourly, and sub-hourly is essential



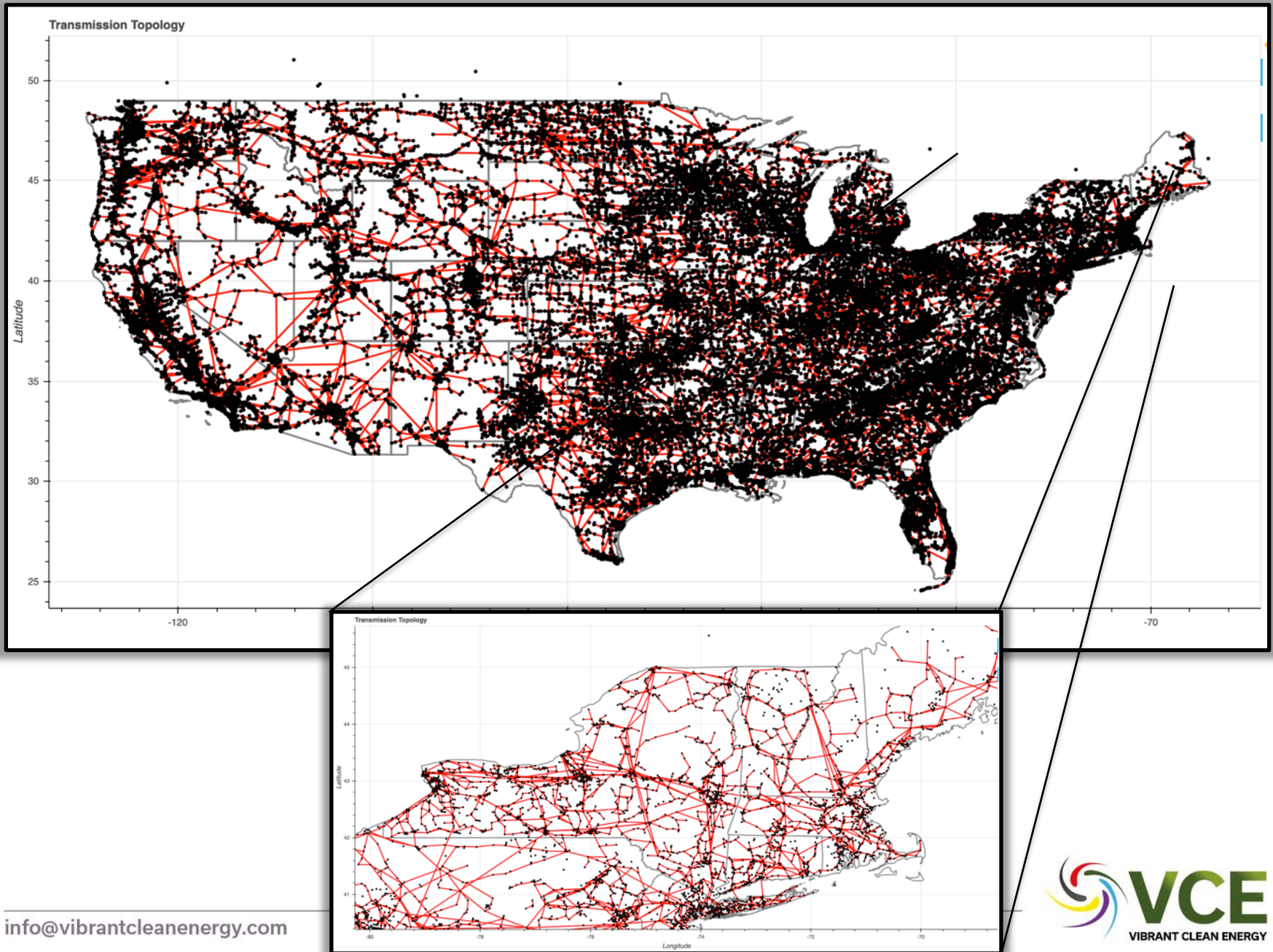
The behavior of storage becomes more important over time



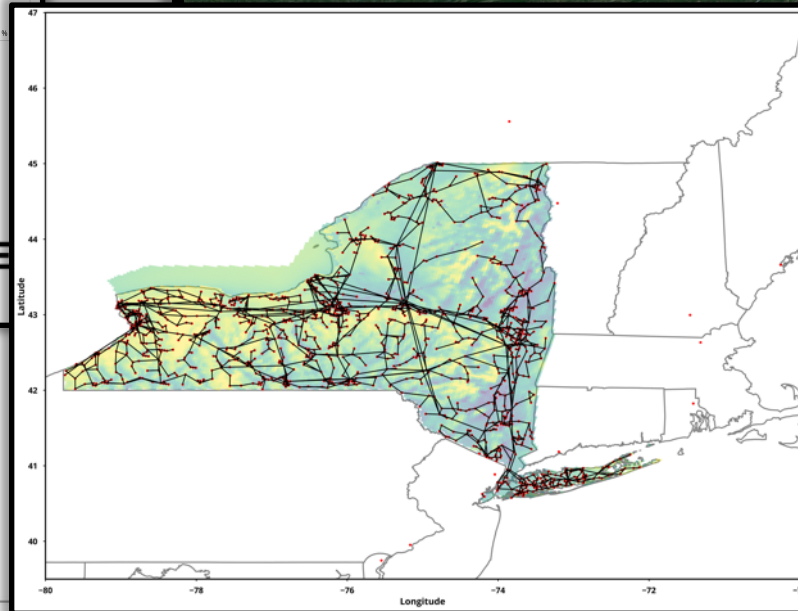
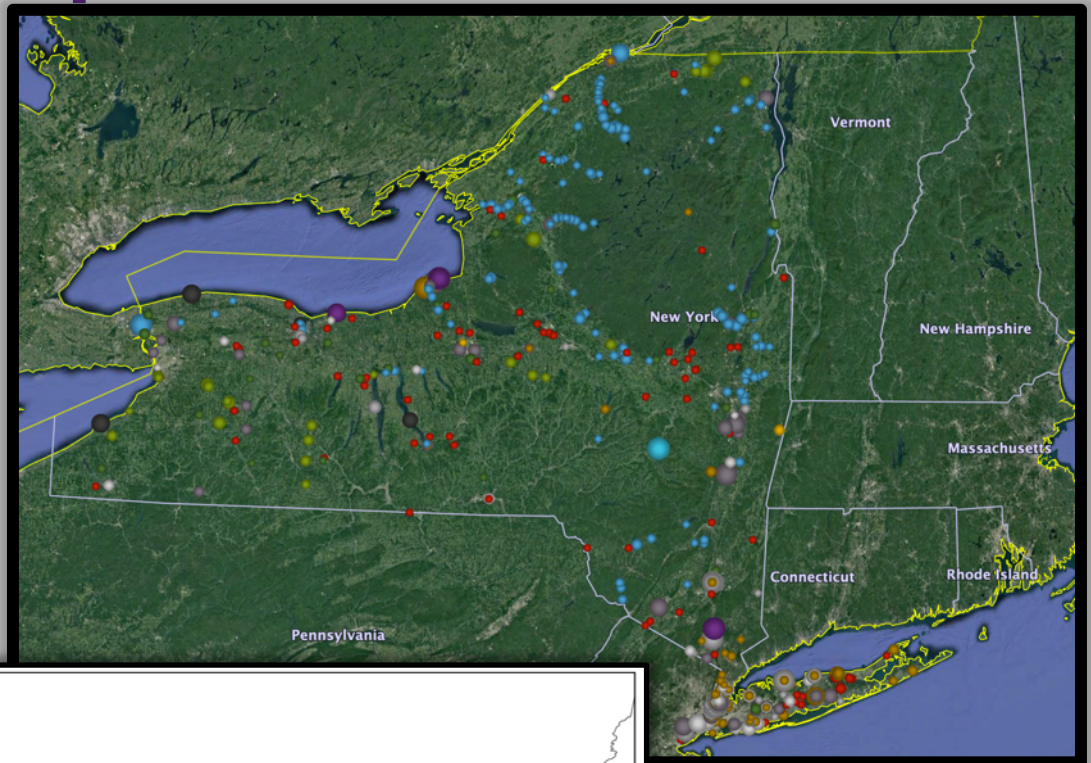
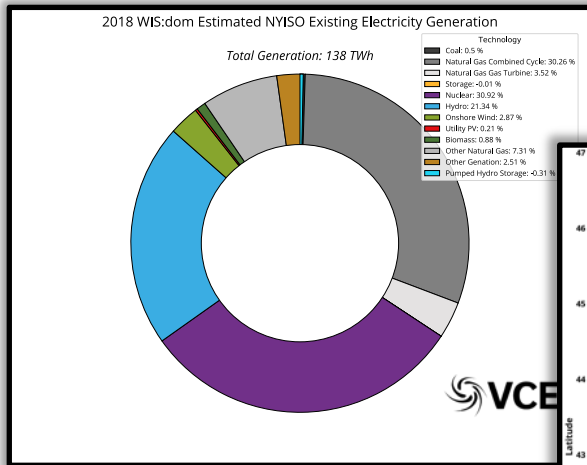
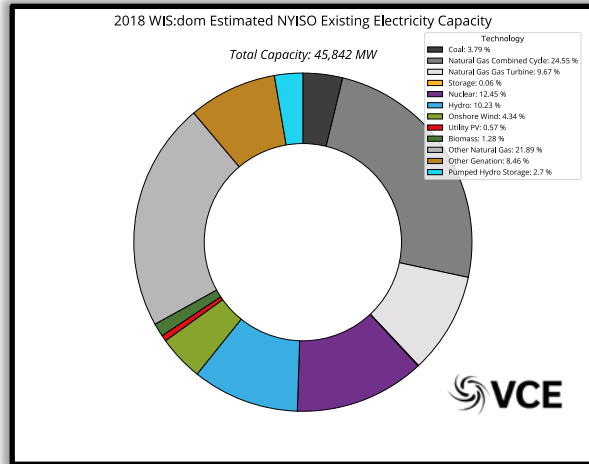
We must start from the grid we have



Resolving the transmission grid topology



Close up of New York

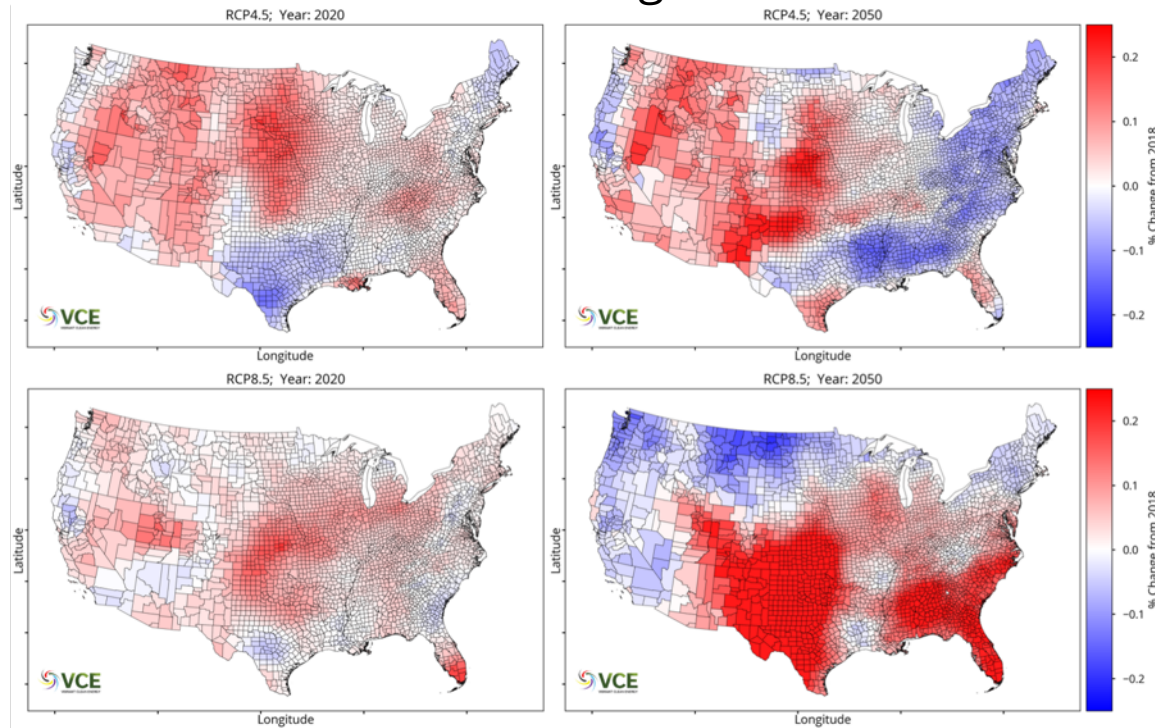


Climate change should be incorporated

Overview:

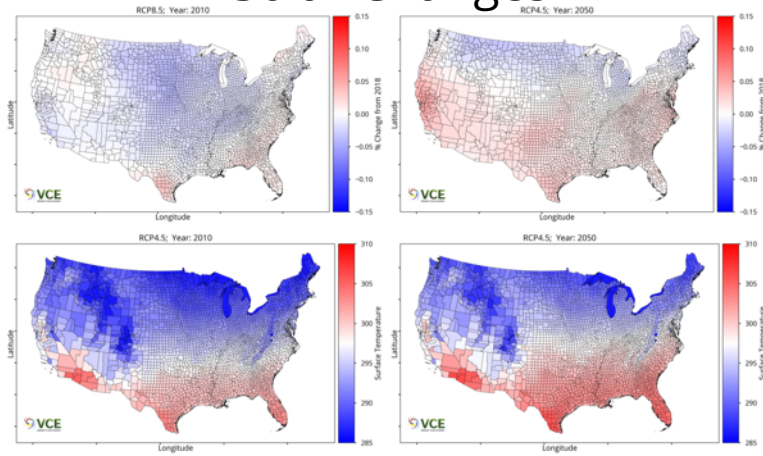
- The CMIP5 datasets allow WIS:dom® to incorporate the changing climate and its impacts on energy infrastructure. Currently this is achieved through:
 - ✓ Changes to the demand profiles;
 - ✓ Changes to the wind and solar power production;
 - ✓ Changes to the water supply for thermal generation and hydroelectric power plants;
 - ✓ Changes to the transmission line ratings and line losses via the dynamic line rating;
 - ✓ Changes to the heat rates of the power plants due to thermal efficiency;
 - ✓ Changes to the flexibility profiles for the demands.

Wind Changes

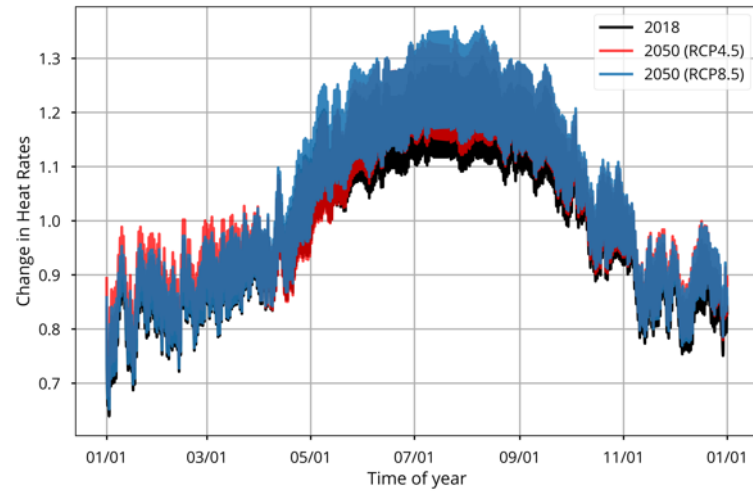


Overview of Climate Input Data

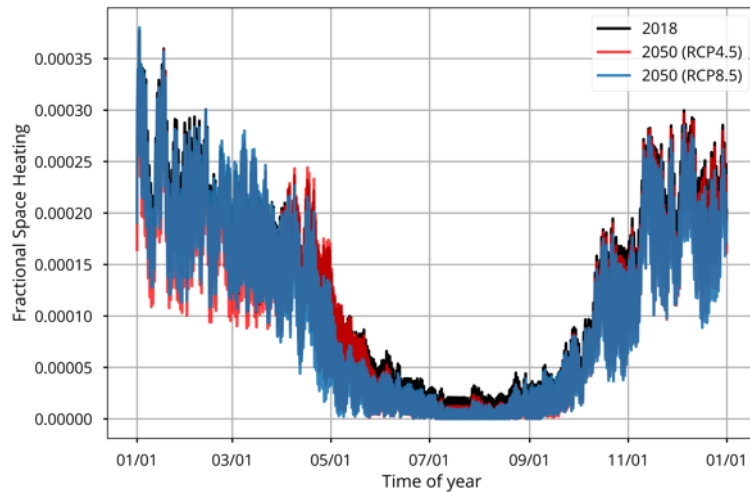
Solar Changes



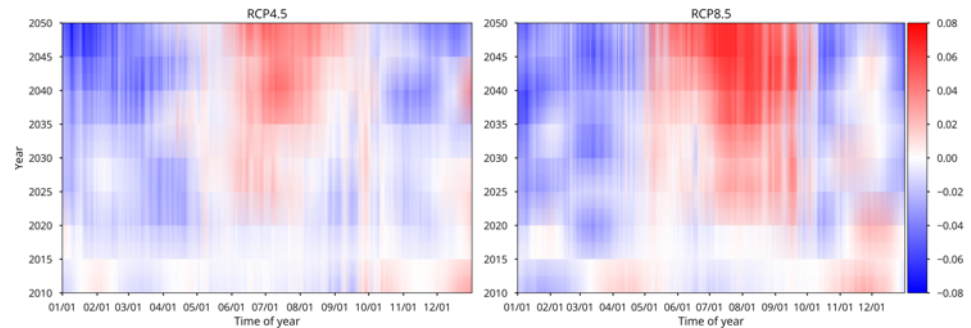
Heat rate changes



Space heating changes



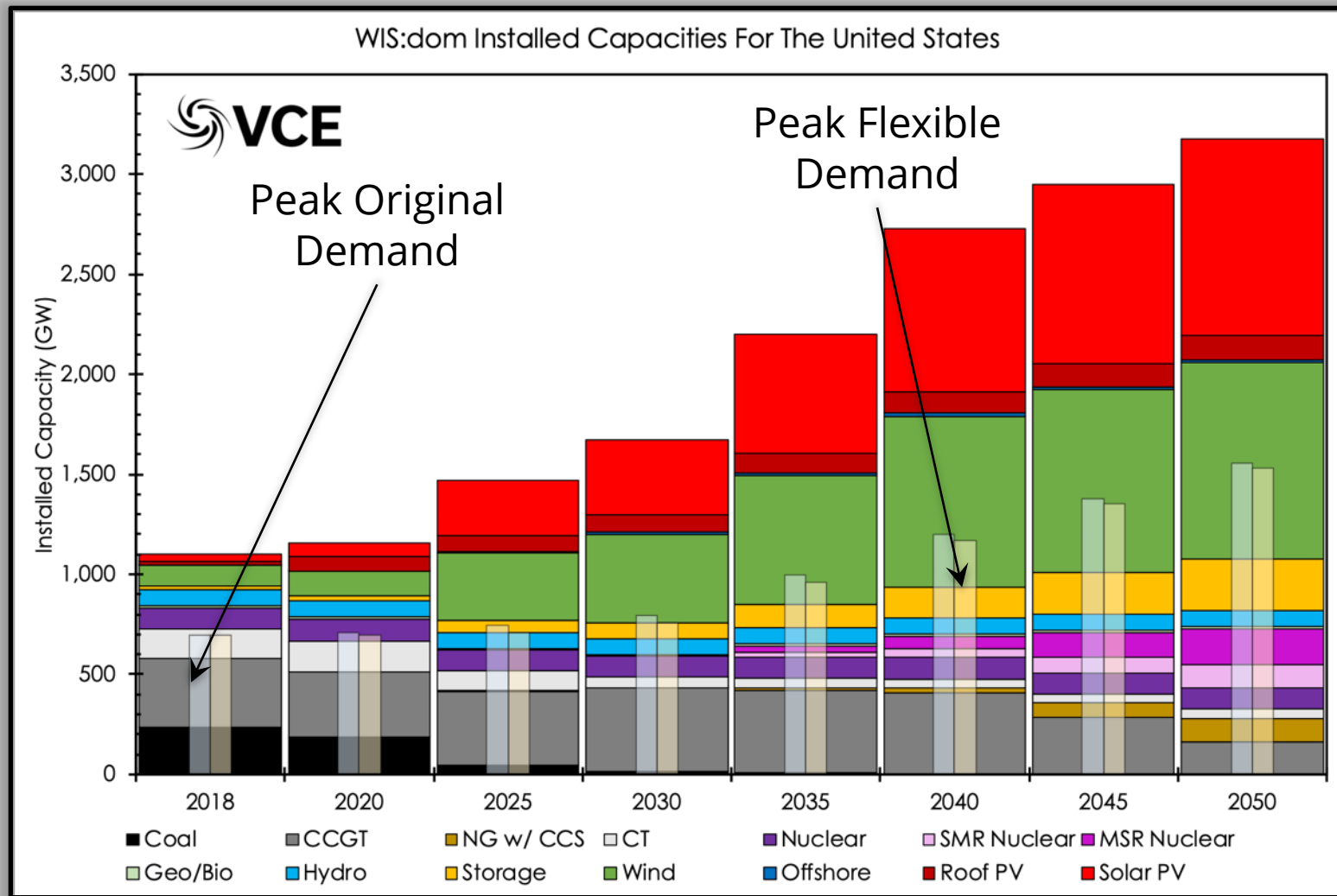
EV charging changes



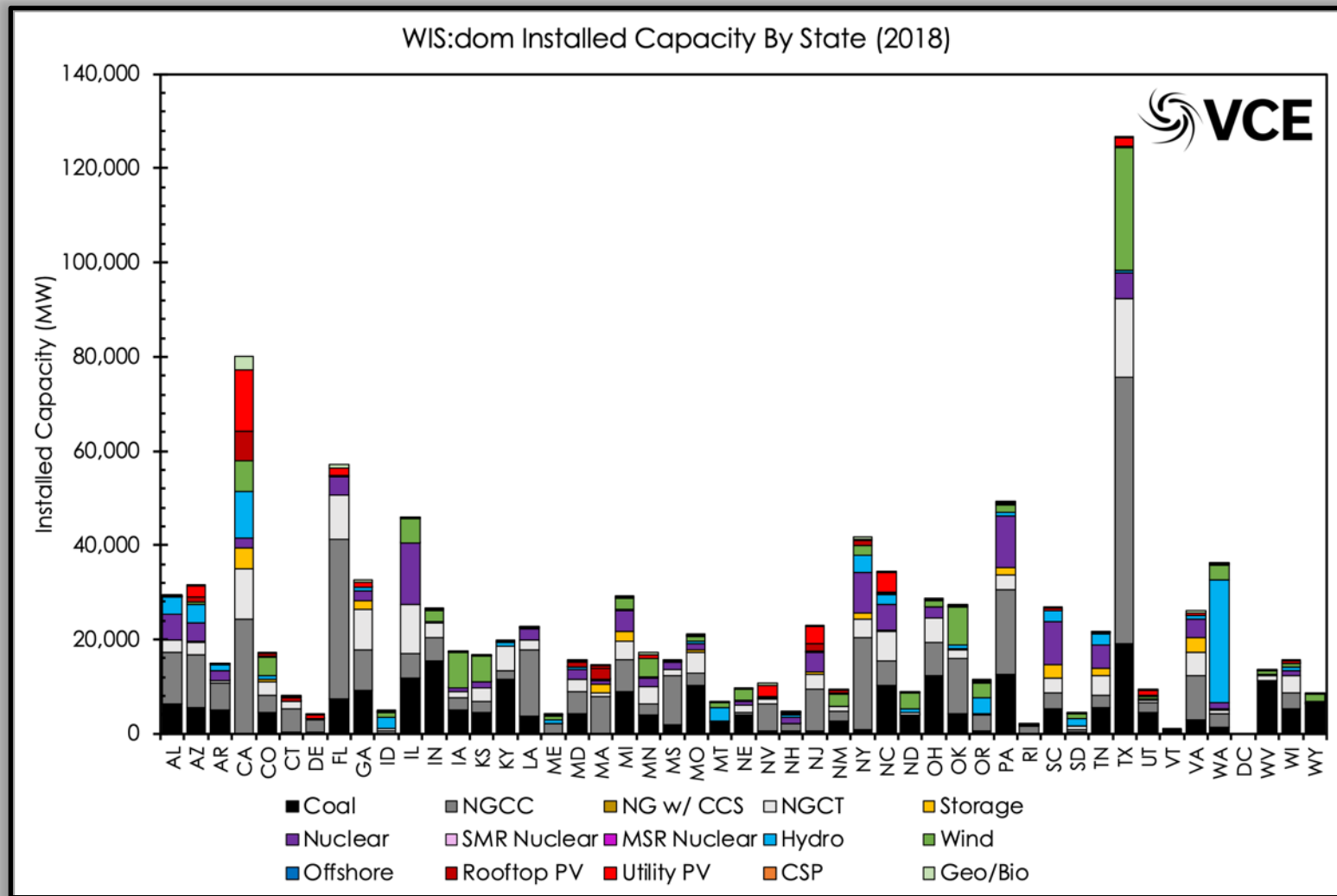
WIS:dom[®]-P Case Study

CONUS Deep Decarbonization Study

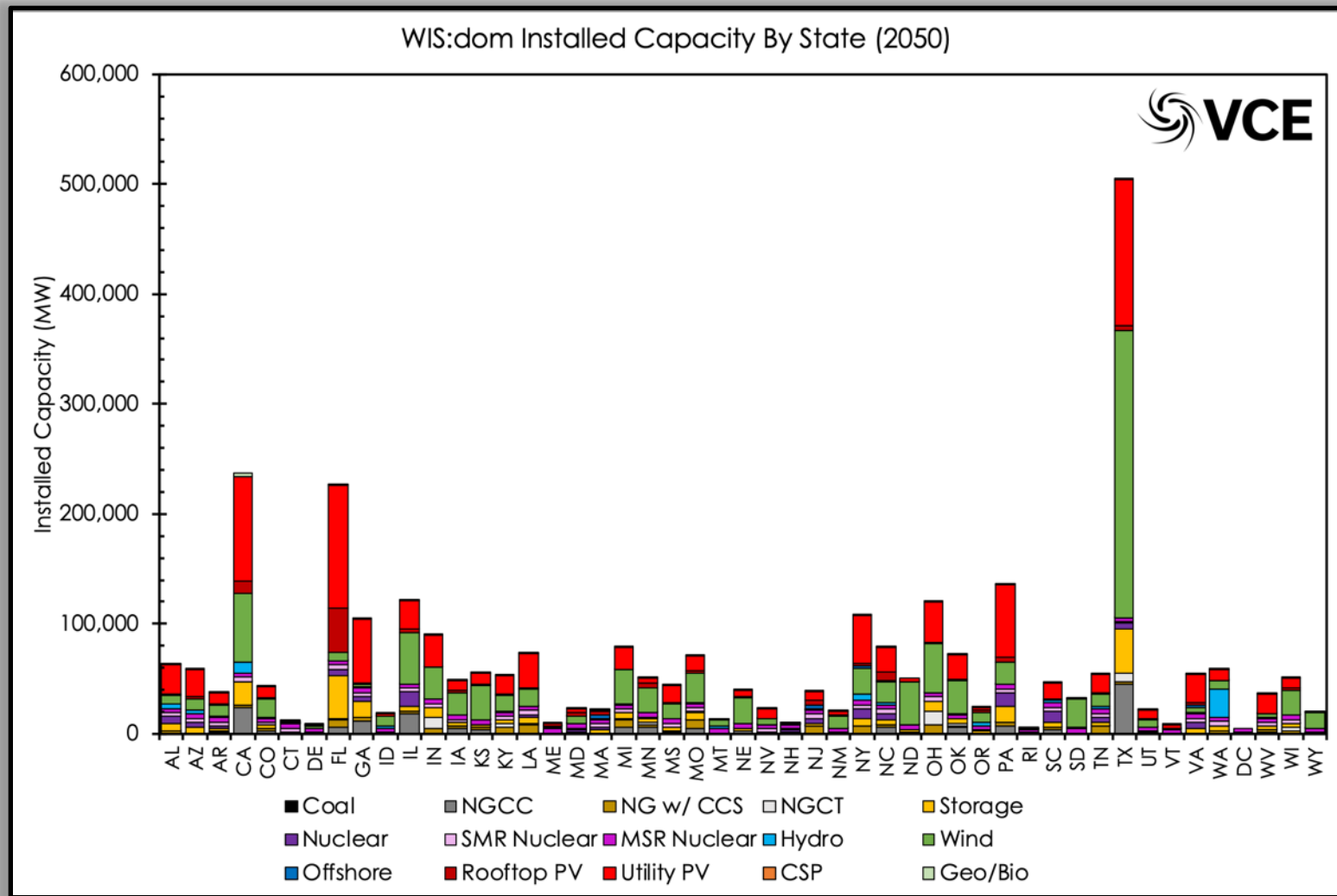
Installed Capacities



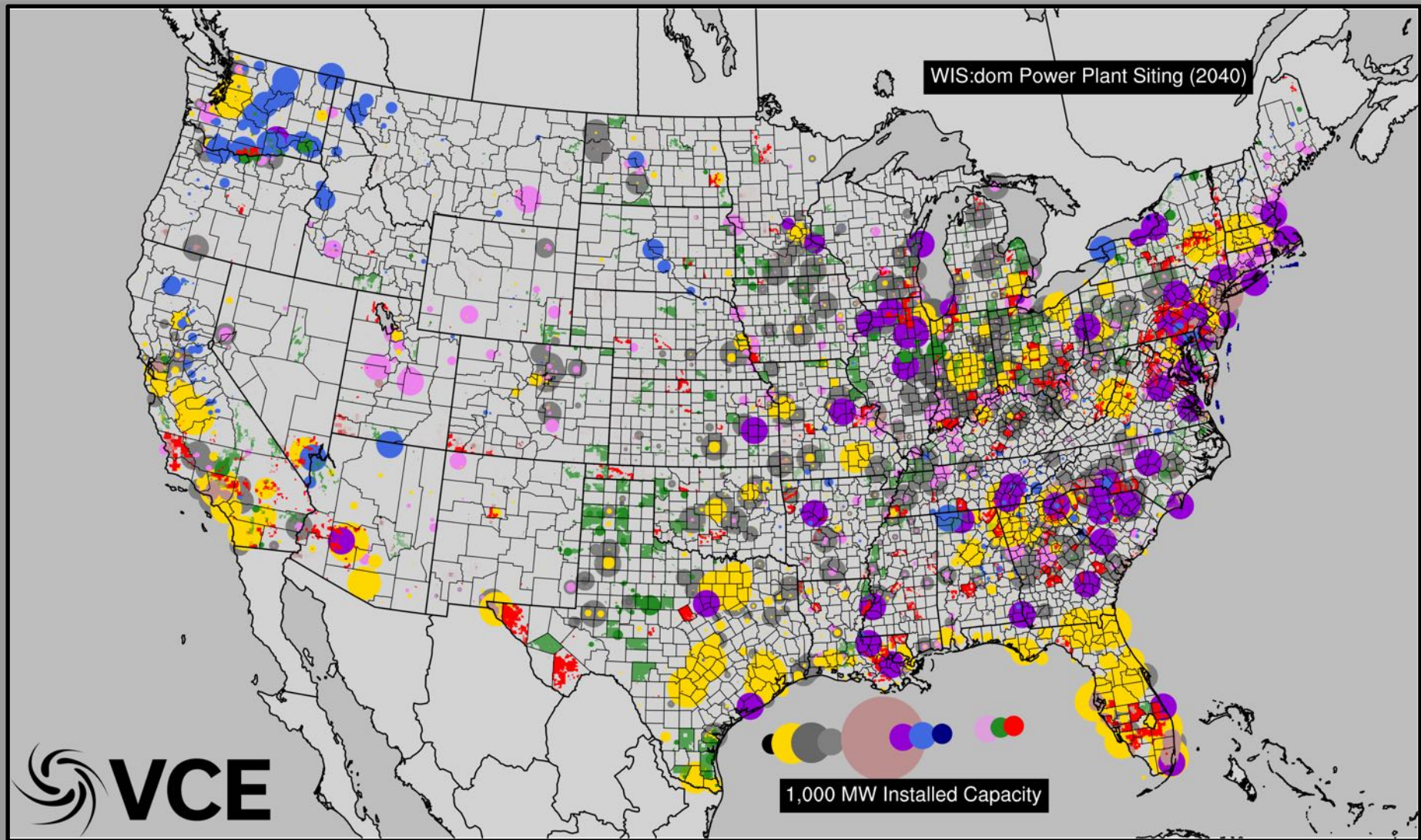
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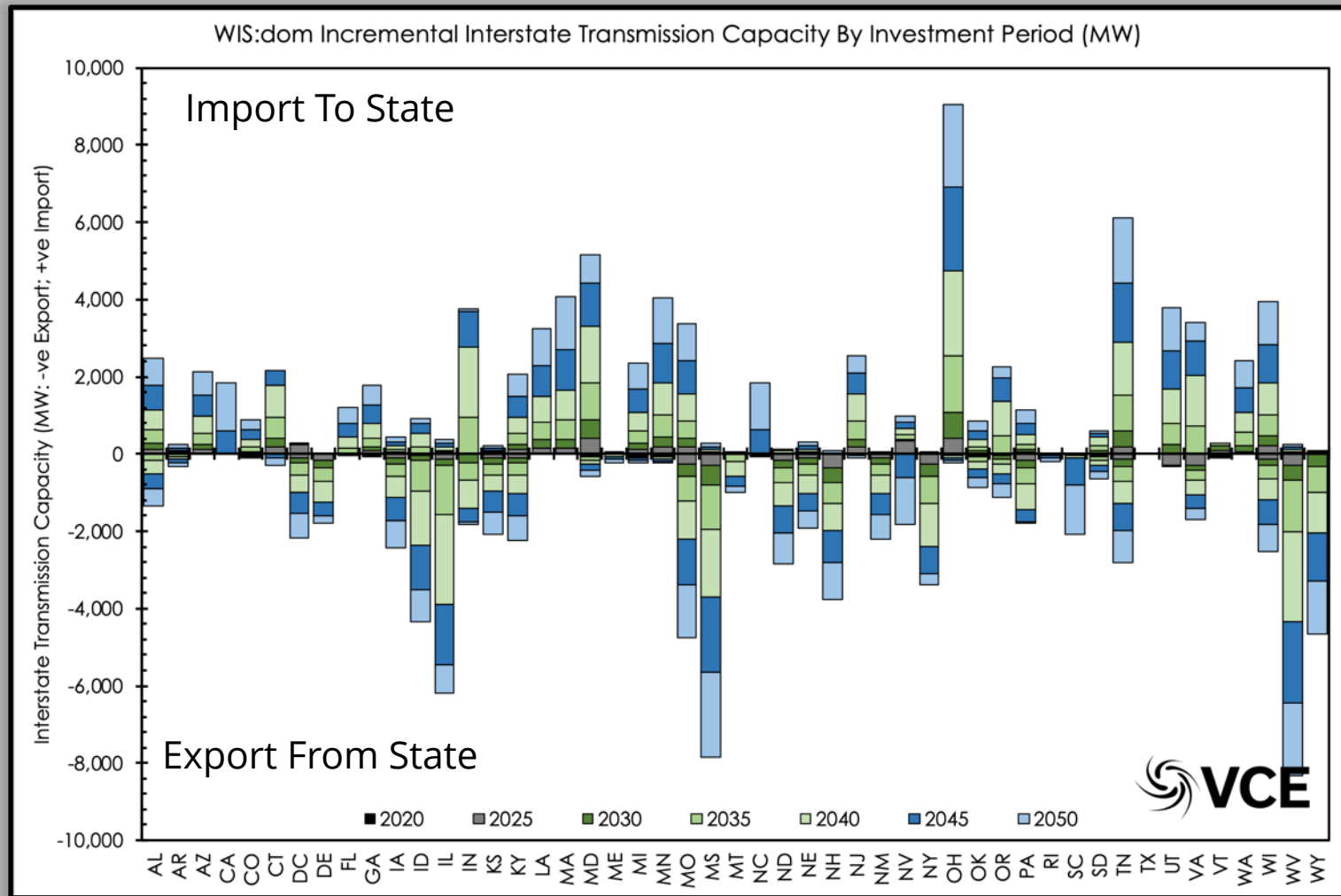
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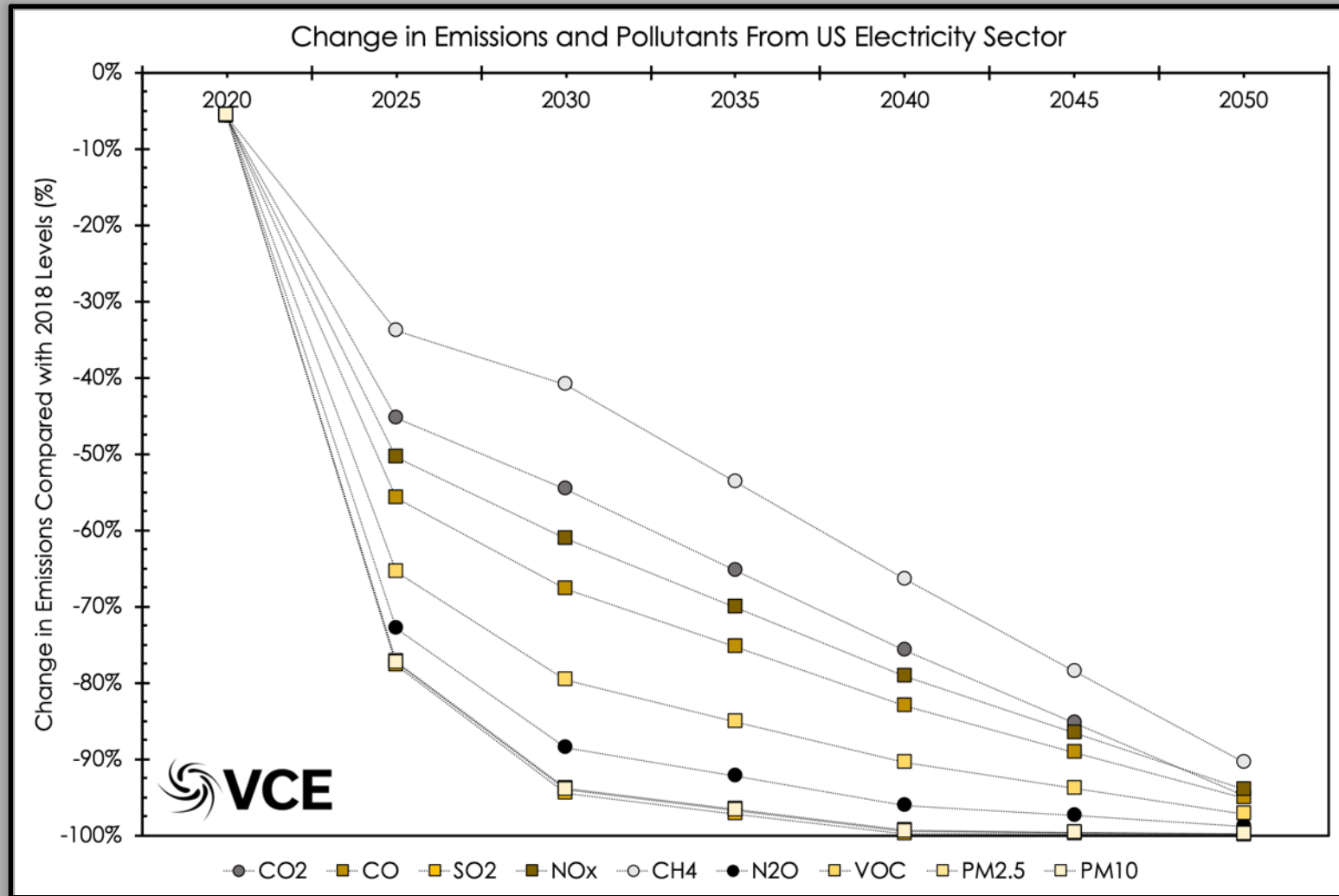
Installed Capacities



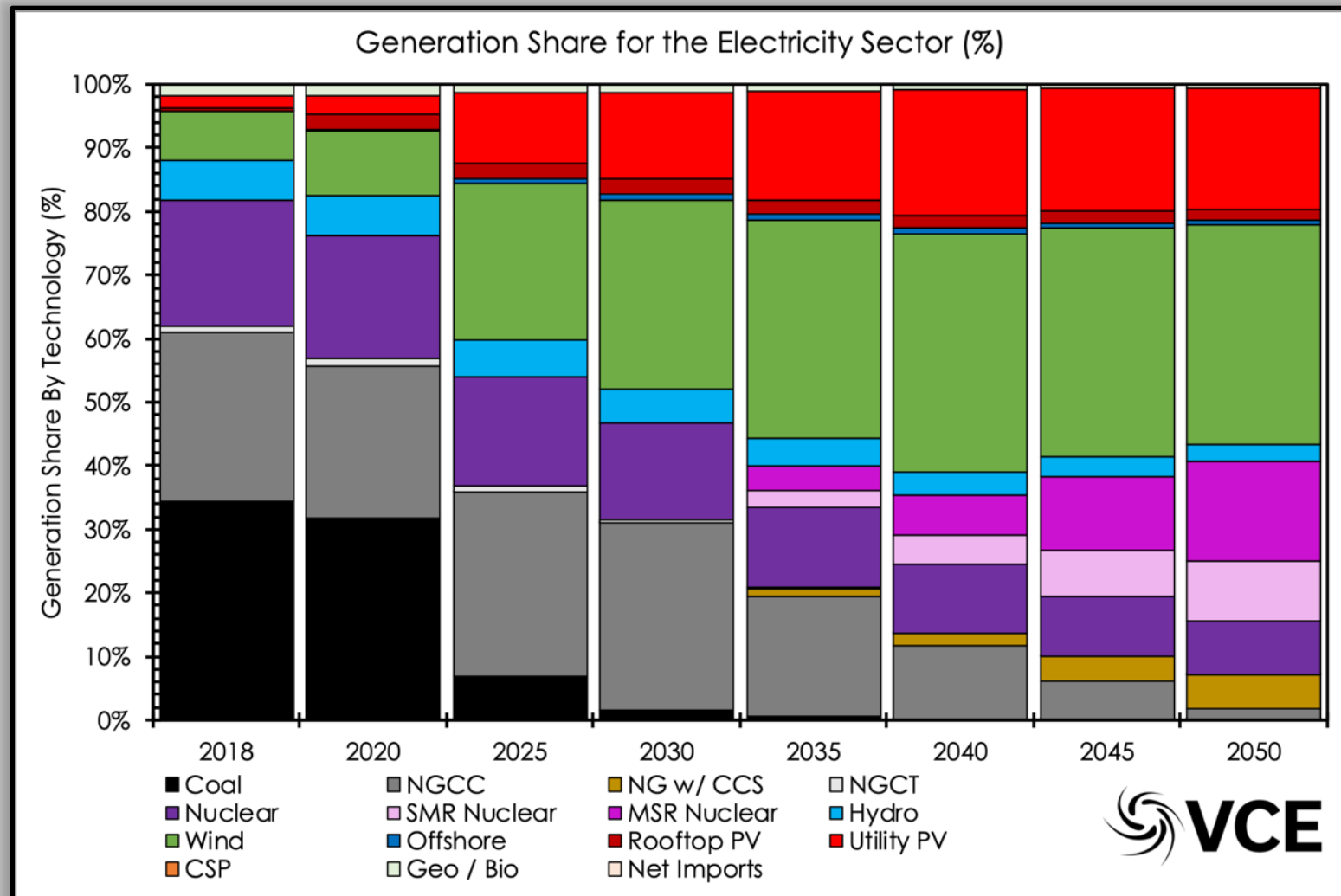
Installed Transmission Capacities



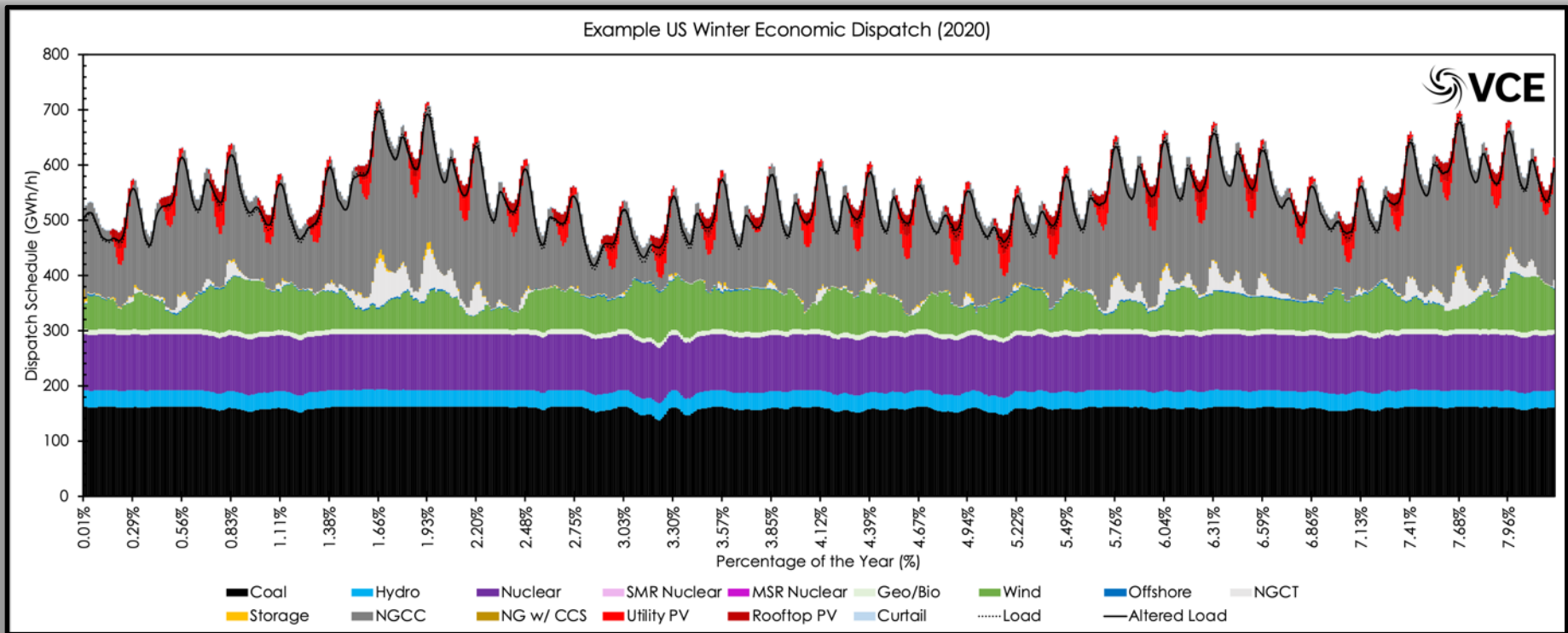
Changes in Emissions & Pollutants



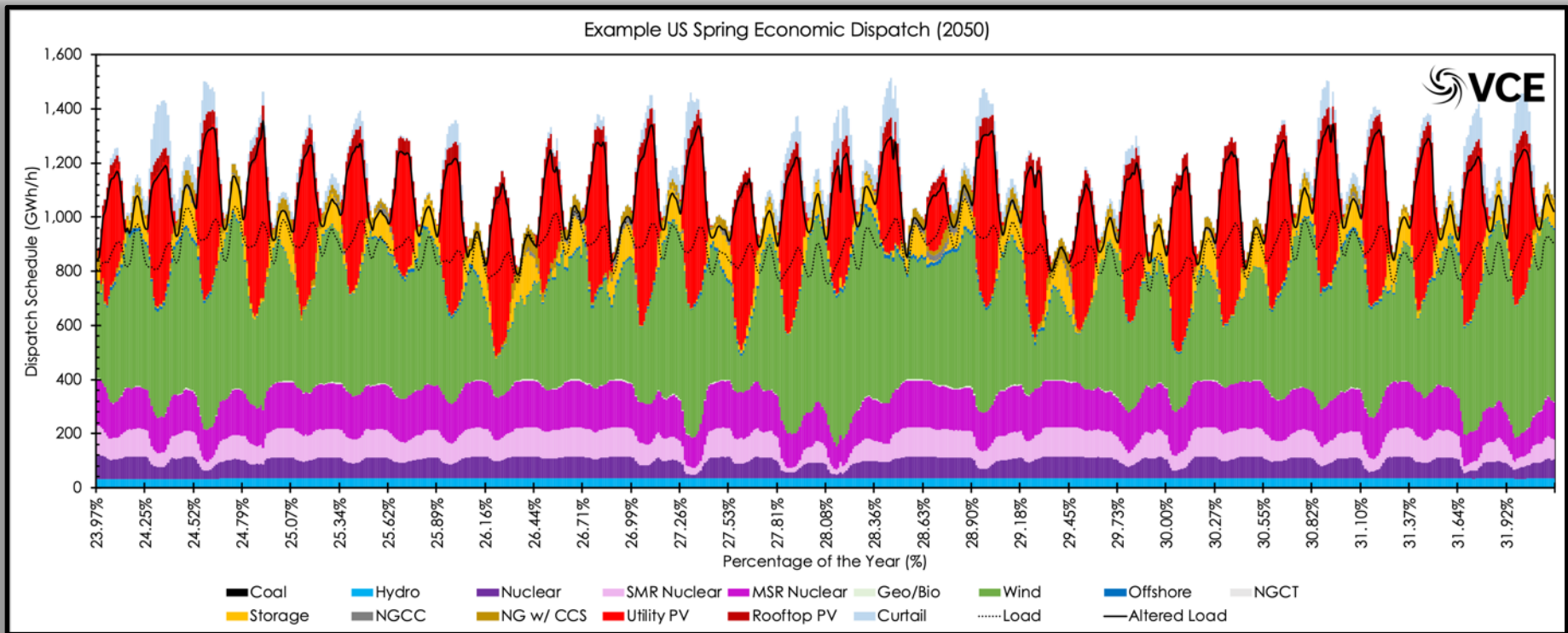
Generation Mix (%)



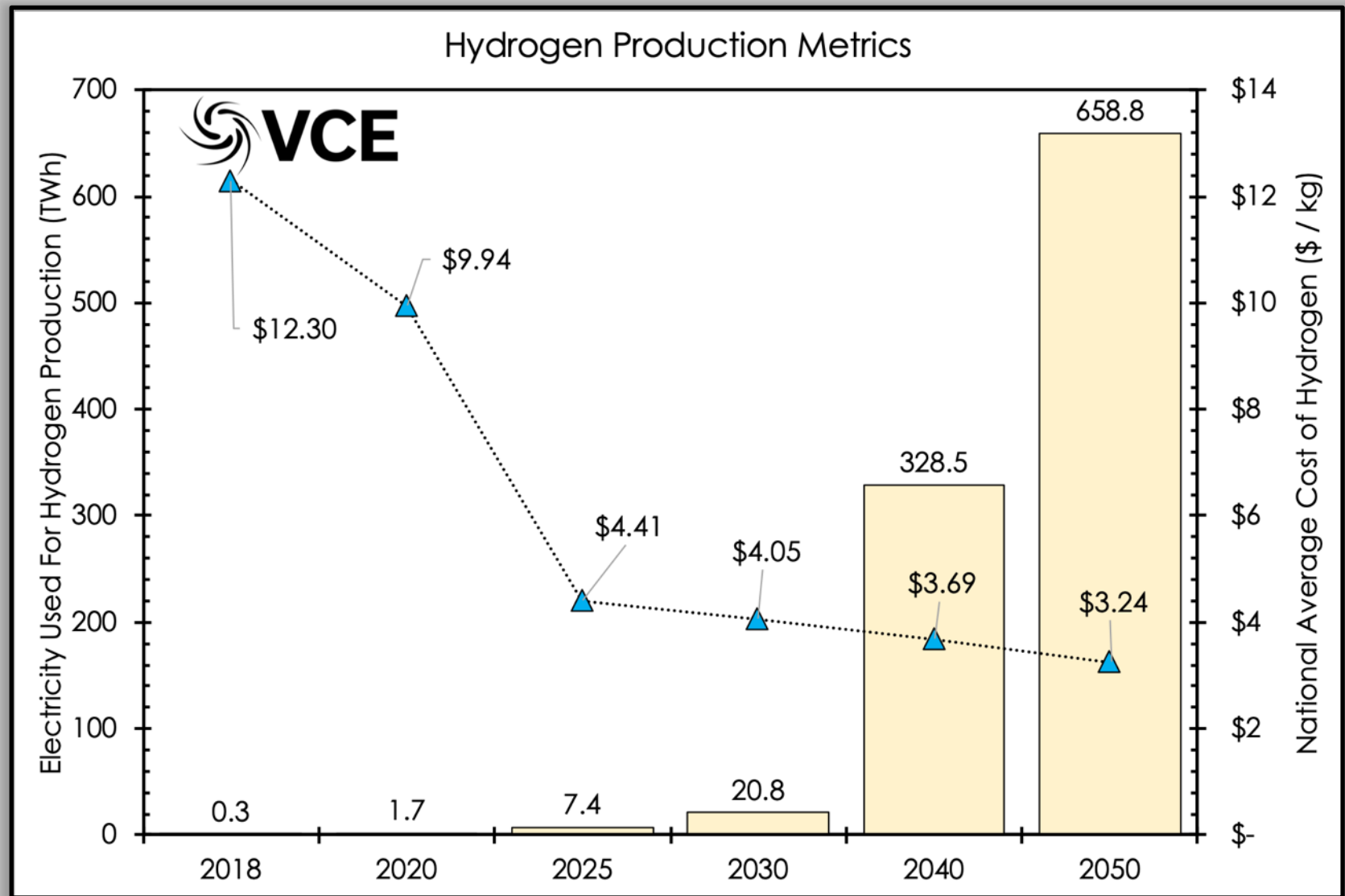
Economic Dispatch



Economic Dispatch



Hydrogen Economy Enabled



Thank You Questions?

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